84-4011 Bruce GS `B' preoperational biological study, year III, 1981 (Ont. Hydro)

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BRUCE GS 'B' PREOPERATIONAL BIOLOGICAL STUDY YEAR III 1981

Report No 83-451-K

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ABSTRACT

Physical, chemical and biological characteristics of the aquatic environment in the vicinity of Bruce GS 'B' were studied from May to December, 1981. Sediment loads were highest and water transparency lowest during the fall. The nearshore temperature regime was unstable, particularly in summer when water temperatures fluctuated from 8 to 23°C due to the influence of mass water movements. Few alongshore trends were seen in physical and chemical characteristics. Biological studies included attached algae, zoobenthos and fish. Overall, *Ulothrix* dominated the attached algae. The zoobenthos was dominated by oligochaetes at 1 to 3 m and by chironomids at 7 to 12 m. Highest zoobenthic density and diversity occurred in Holmes Bay, which is relatively more protected from wave action and has a finer, more heterogeneous substrate than other locations. Alewife, longnose and white suckers, rainbow smelt and spottail shiner appeared to be the most abundant fish species. Ripe and post-spawn round whitefish were taken in moderate numbers at the 3 m depth in late fall.

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To Dr. W.R. Effer
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BRUCE GS 'B' PREOPERATIONAL BIOLOGICAL STUDY YEAR III 1981

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1.0 INTRODUCTION

The third year of preoperational studies at Bruce GS 'B' was conducted from May to December 1981. The preoperational studies, which commenced in 1979, were requested by Environmental Studies and Assessments, Design and Development Division. Their objective is the acquisition of detailed information on the aquatic environment in the vicinity of Bruce GS 'B'. This data will be compared with data collected during commissioning and operation of the station to evaluate the effect of constructing and operating Bruce GS 'B' on the environment.

This was an intensive study year, in which a broad range of biotic and abiotic features was examined in detail. In scope it resembled the Year I (1979) Bruce GS 'B' study, with the major exception that phytoplankton and zooplankton, though collected, were stored without examination (explanation in methods). Fish populations continued to be the most intensively sampled component of the aquatic environment, and increased emphasis was placed on the distribution of ichthyoplankton and round whitefish.

During the study period excavation of the Bruce GS 'B' cooling water intake was carried out (May to September 1981).

The study area extended from Douglas Point GS in the north to McRae Point (for some aspects) in the south (Figure 2-1A). Sampling was conducted from the shoreline up to 2 km offshore.

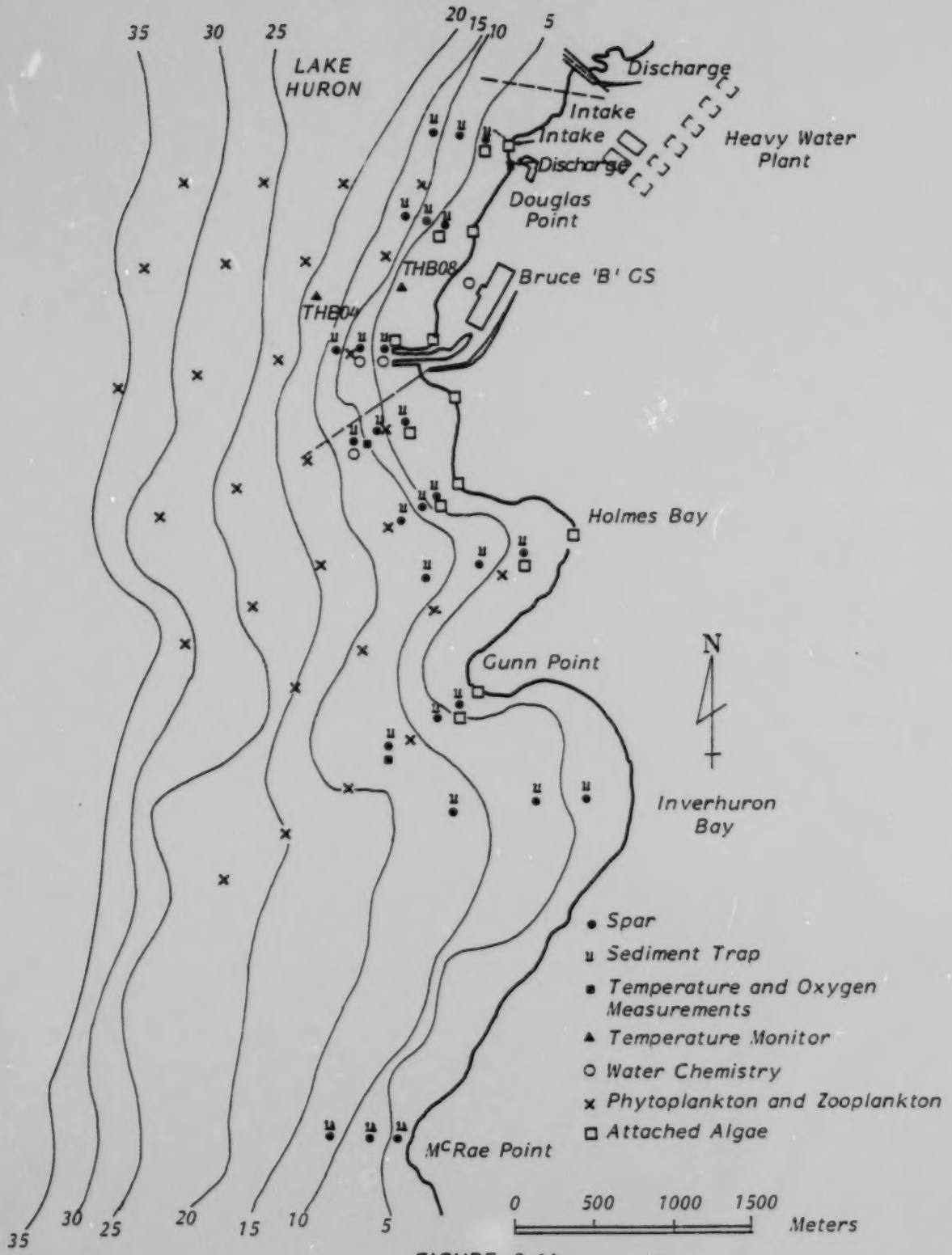

FIGURE 2-1A

SAMPLING LOCATIONS AND TYPES OF SAMPLES
TAKEN BRUCE GS 'B', 1981

161203 RD

2.0 METHODS

The complete sampling schedule for physical and biological characteristics is shown in Table 2-1.

2.1 Physical Characteristics

Substrate

Substrate photographs were taken during the 1981 field season to fill gaps in the 1980 results. A rectangular metal frame (45 by 60 cm), constructed of 1/4" square steel, with an upper framework that supports the camera 0.8 m above the bottom was used to standardize picture area. Locations photographed in 1980 and 1981 are listed in Table 2-2. Complete sampling was prevented by unfavourable weather, and further attempts were planned for 1982.

Sedimentation

Sediment traps consisting of sets of four upright tubes, inside diameter 5 cm and height 63 cm, were set in May at the 3, 7 and 12 m depth contours on the nine transects shown in Figure 2-1A. Traps were recovered and reset in July and September, with final recovery occurring in November. Recovered material was dried to constant weight at 105°C, weighed, ashed at 525°C for 2 h and reweighed. Dry weight of samples gives total sedimentation. Combustion of samples results in loss-on-ignition of a portion of the samples including organic material. For convenience the material remaining has been termed inorganic sediment, and the portion lost (difference between total and inorganic) called loss-on-ignition or, in earlier reports, organic sediment. The percentage of the total sediment lost after combustion is referred to as the per cent loss-on-ignition, formerly per cent organic content.

High winds and rough lake conditions resulted in the loss, damage or overturning of tubes at five sampling locations during the middle sampling period (July to September) and at all but six sampling locations during the final sampling period (September to November).

Temperature, Oxygen and Transparency

Lake water temperatures were continuously monitored by Hydraulic Studies and Development Dept at two locations off Bruce GS 'B' (THB08, THB04, Figure 2-1A)). In addition, oxygen and temperature profiles were obtained from June to December at the 12 m

TABLE 2-1

SAMPLING SCHEDULE, BRUCE GS 'B' 1981

	Month							
	May	June	July	Aug	Sept	Oct	Nov	Dec
Substrate Photographs				------				
Sediment Tubes	X---------X-------X--------X							
Temperature, Oxygen Profiles			X*X	X		XX		X
Water Chemistry	X	X	X	X	X		X	
Phyto & Zooplankton Grids			X	X		X		
Zoobenthos		X				X		
Attached Algae		X				X		
Fish:								
Ichthyoplankton	XX	XX	XX	X				
Gill Nets	X	X	X	X	X	X	X	
Trap Nets	X	X	X	X	X	X		
Beach Seines	X	X	X	X		X		
Acoustic Fish Census - Day		X	X		X		X	
- Night		X	X					
Whitefish Spawning						X	X	

* In some cases sampling was originally scheduled for the previous month, but was delayed by adverse weather or equipment malfunction.

depth on the intake and Gunn Point transects. Transparency was obtained in conjunction with the plankton sampling grids (Section 2.3).

TABLE 2-2

SUBSTRATE PHOTOGRAPHS
BRUCE GS 'B'

	On Transects						
	Shoreline	1 m	3 m	5 m	7 m	9 m	12 m
Douglas Pt	✓		✓		✓		✓
Lagoon Bay	✓		✓		✓		✓
Bruce GS 'B' Discharge	✓		✓	X	✓		✓
Bruce GS 'B' Intake	✓		✓		✓		✓
S. Boundary Rd	✓	X	✓		✓		✓
Holmes Bay	✓	X	✓		✓		✓
Gunn Pt	✓	X	✓		✓		✓
Inverhuron Bay	✓	X	✓		✓		✓
McRae Pt	✓	X	✓		✓		✓

	Between Transects						
	Shoreline	1 m	3 m	5 m	7 m	9 m	12 m
Douglas - Lagoon	✓						
Lagoon - Discharge	✓				X		
Discharge - Intake	✓						
Intake - S. Boundary	✓	X					
S. Boundary - Holmes	✓	X					
Holmes - Gunn	✓	X					
Gunn - Inverhuron	✓	X					
Inverhuron - McRae	✓	X					

✓ - 1980 X - 1981

2.2 Water Chemistry

Water quality samples were collected at the surface and bottom at 12 m on the Bruce GS 'B' intake transect and at the surface at the 3 and 7 m discharge locations. Samples were collected with a Van Dorn bottle at all locations. Parameters are listed in Table 2-3.

TABLE 2-3

WATER CHEMISTRY PARAMETERS

Colour	Suspended Solids and Ash - mg/L
Conductivity - mS/m	Dissolved Solids and Ash - mg/L
Turbidity - ntu	Biological Oxygen Demand - mg/L
pH	Chemical Oxygen Demand - mg/L
Total Phosphorus - µg/L	
Soluble Phosphorus - µg/L	Total Kjeldahl Nitrogen - mg/L
Magnesium - mg/L	Soluble Nitrogen - mg/L
Orthophosphorus - µg/L	
Particulate Phosphorus	Nitrite Nitrogen - mg/L
Total Silica - mg/L	Nitrate Nitrogen - mg/L
Soluble Silica - mg/L	Ammonia - mg/L
Calcium - mg/L	Chlorophyll *a* - g/L

2.3 Biological Characteristics (Excluding Fish)

Phytoplankton and Zooplankton

Phytoplankton and zooplankton were sampled in early July, August and October at 28 points along the seven transects from Douglas Point to Gunn Point. The sampling locations began 500 m from shore and extended to 2000 m in 500 m intervals (Figure 2-1A). Zooplankton samples were collected with a 27 L Schindler-Patalas trap with 64 µ mesh in the straining bucket. Duplicate surface hauls were performed at each sampling location. Phytoplankton samples were obtained with a 3 m integrated tube. Dissolved oxygen, temperature and Secchi disc readings were obtained at each sampling location in conjunction with the phytoplankton and zooplankton samples.

Samples were stored but not analyzed. Ontario Hydro's position was that the cost of obtaining additional plankton data was not justified in comparison to its usefulness in assessing station operation or construction effects. The Ministry of the Environment asked that the samples be collected in the event that examination of other data indicated that analysis would be advantageous.

Attached Algae

Attached algae were collected in June, August and November at the shoreline and 3 m locations on the seven transects from Douglas Point to Gunn Point (Figure 2-1A). Triplicate 25 cm^2 samples

were scraped from rock surfaces at each location. Water temperatures were obtained at the shoreline and 3 m bottom on each transect.

Zoobenthos

Zoobenthic samples were collected during June-July and October-November at the 1, 3, 7 and 12 m depths on the seven transects from Douglas Point to Gunn Point (Figure 2-1B). Triplicate samples were obtained at each location with a 105 cm^2 dome sampler and slurp gun. Substrate type and per cent algal cover were recorded for each sampling location. Dissolved oxygen and temperature measurements were obtained 1 m above the substrate. Secchi depth was determined at each sampling point.

2.4 Fish

Ichthyoplankton

Larval fish were collected at dusk on seven sampling dates from May 14 to August 6. Duplicate surface tows were conducted parallel to shore along the 1, 3 and 7 m depth contours on each of the six transects from Lagoon Bay to Gunn Point (Figure 2-1B). Duplicate bottom tows were also performed along the 7 and 12 m depth contours at the Bruce GS 'B' intake transect. All tows were conducted with 0.5 m nets, 363 µ mesh, over a 5 minute time period.

Adult and Juvenile Fish (Monthly Netting Survey)

Adult and juvenile fish were collected in gill nets, trap nets and beach seines during 1981. Experimental gill nets were set on bottom at 3 and 12 m depths at Douglas Point, Bruce GS 'B' discharge, Bruce GS 'B' intake, Holmes Bay, Gunn Point and McRae Point monthly from May to November (Figure 2-1B). Two consecutive 24 h net sets were obtained during all months except September when the second set could not be obtained at any of the above locations due to unfavourable weather conditions. Only one set was obtained at the Douglas Point 3 m location in October due to weather conditions. Length, weight and scale samples were obtained from 100 round whitefish and all salmonids.

Experimental gill nets were composed of meshes ranging from 2.5 cm (1") to 12.7 cm (5"), in 1.3 cm (1/2") increments. The smallest mesh, however, was not available for every net due to supply problems; hence meshes of 3.8 cm to 12.7 cm were used as the standard experimental net for data analyses purposes. Catch statistics for 2.5 cm mesh were analyzed separately.

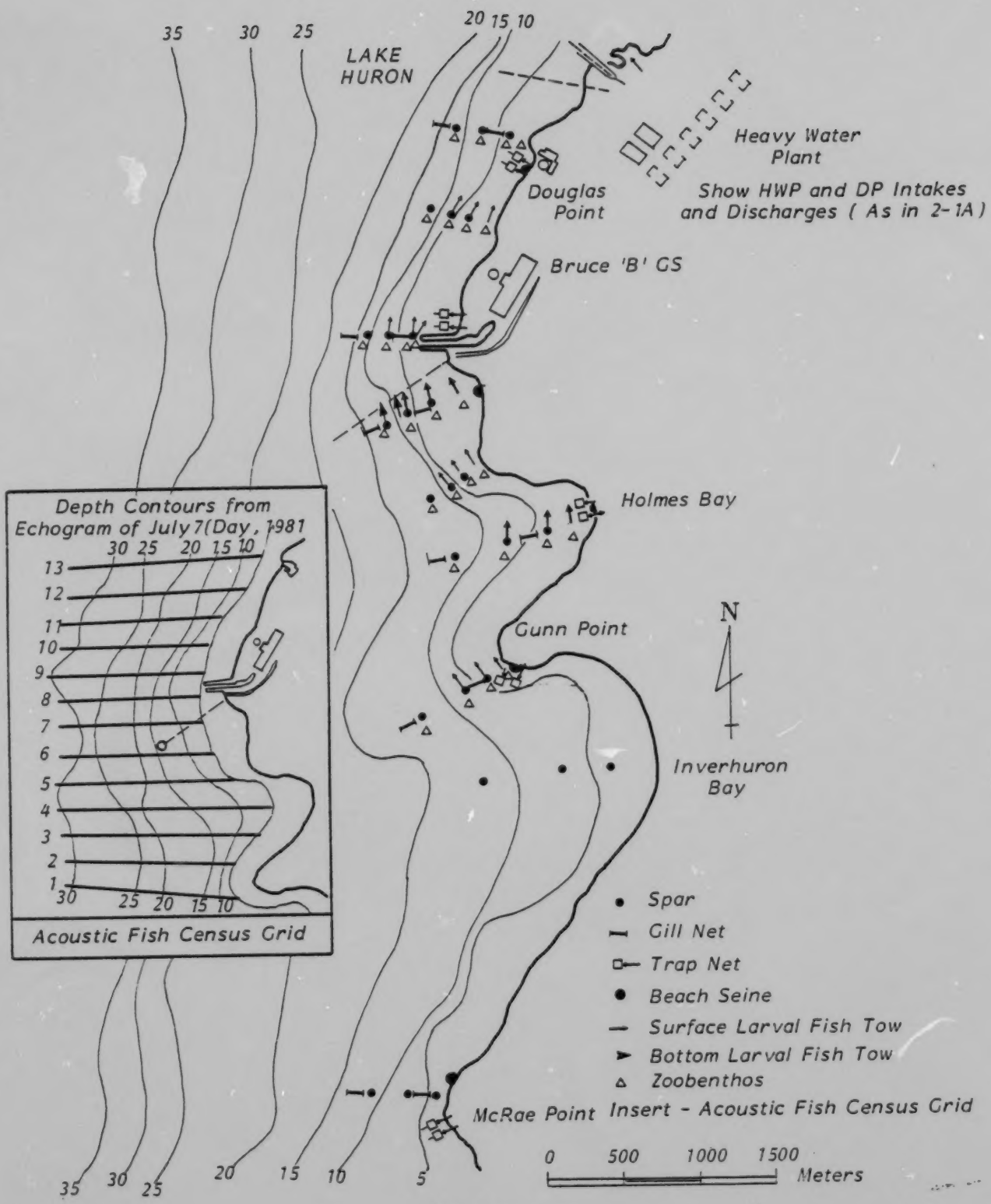

FIGURE 2-1B

ZOOBENTHOS AND FISH SAMPLING LOCATIONS
BRUCE GSB, 1981

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Paired 1.2 m (4 ft) trap nets were set for two consecutive 24 h periods at Douglas Point, Bruce GS 'B' discharge, Holmes Bay, Gunn Point and McRae Point in May, June and August (Figure 2-1B). The trap boxes were fished at 2 to 3 m depth. Due to unfavourable lake conditions only one 24 h trap net set was obtained at all locations in July and at Douglas Point in September, and no nets were set at Douglas Point or the Bruce GS 'B' discharge in October.

Triplicate beach seine hauls were taken at Douglas Point, Bruce GS 'B' intake, Holmes Bay, Gunn Point and McRae Point in June, July, August and October (Figure 2-1B). September beach seine sampling was missed due to unfavourable weather, as were May samples at Douglas Point and the Bruce GS 'B' discharge.

Acoustic Fish Census

Acoustic surveys of fish populations in the vicinity of Bruce GS 'B' were conducted during June, July, September and November (Table 2-1). Equipment failure and adverse weather prevented the collection of some scheduled samples.

Equipment and survey techniques were the same as employed in 1980 (Ontario Hydro Research Division Report 82-205-K). A grid identical to that of 1980 was used, with transects spaced 250 m apart from Gunn Point to Douglas Point. The inshore margin of the grid followed the 5 m contour, while the offshore margin was kept straight to allow consistency in location (Figure 2-1B). Spars marked the offshore ends of the transects.

Temperature profiles were obtained at 200 m intervals along the median transect (#7) and at the inshore corners of the grid (Transects 1 and 13). Experimental gill nets, consisting of mesh sizes ranging from 2.5 cm (1") to 12.7 cm (5"), in 1.3 cm (1/2") increments, were set for a minimum time period of 2 h in the three areas of highest echo concentration.

Whitefish Spawning Study

An expanded fishing program which included the regular Bruce GS 'B' gill netting locations as well as the 3 and 12 m depths at Bruce Heavy Water Plant, MacPherson Bay and Scott Point was carried out to investigate round whitefish spawning during November and December (Figure 2-2) over the entire BNPD site. Due to unfavourable lake conditions this sampling was restricted to two consecutive 24 h gill net sets in late November and one 24 h set in mid-December. The two November

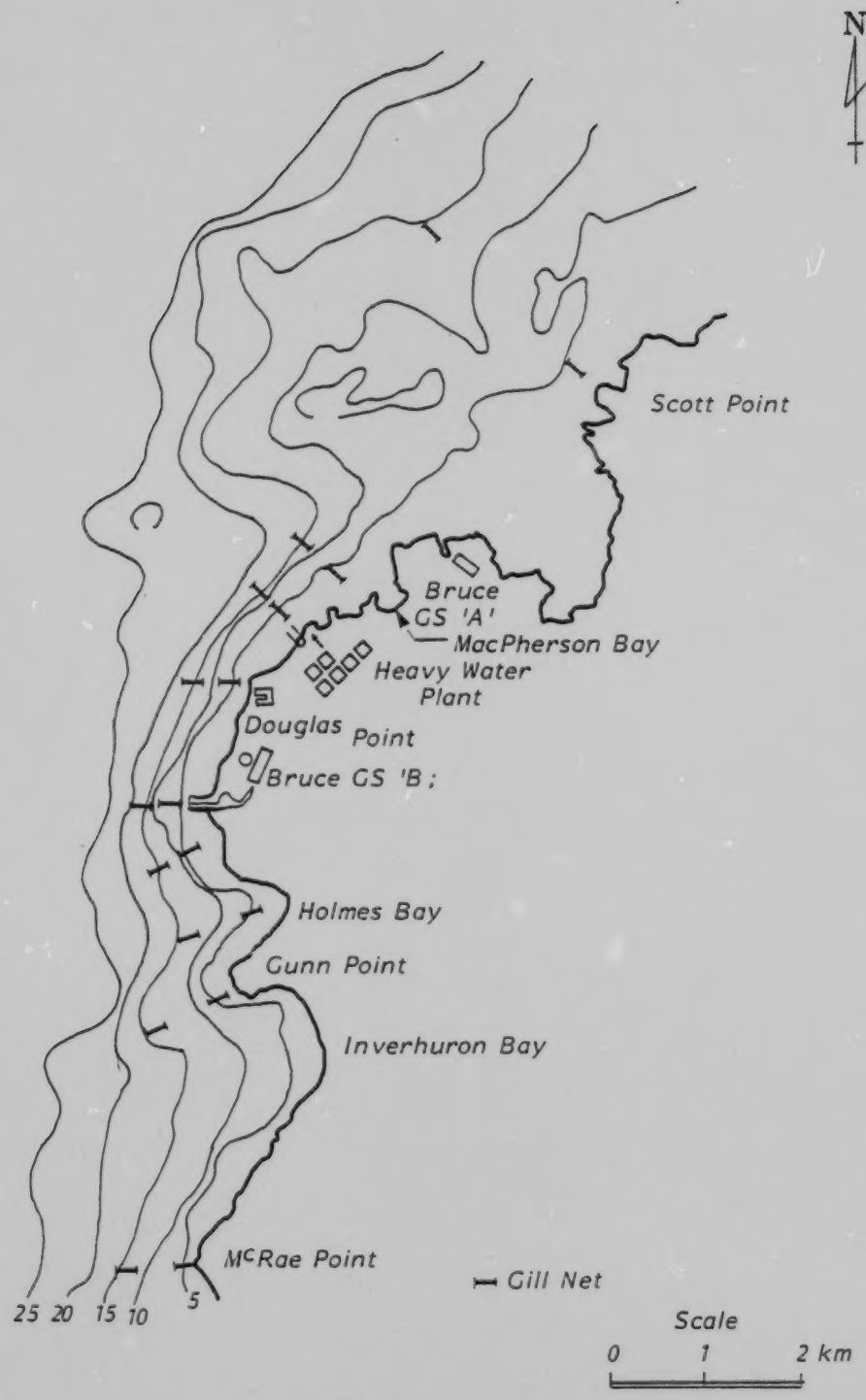


FIGURE 2-2

WHITEFISH STUDY NETTING LOCATIONS
NOVEMBER AND DECEMBER, 1981

161206 RD

sets included the six Bruce GS 'B' locations sampled for the routine survey. Length, weight, sex, gonad condition and scale samples were obtained for the round whitefish caught during November and December.

3.0 RESULTS

3.1 Physical Characteristics

3.1.1 Substrate

Substrate photography during the 1981 sampling season was limited to ten 1-m, one 5-m and one 7-m locations. The composition of the substrate at the locations sampled is summarized in Table 3.1-1 (detailed data on replicates is given in Appendix 1). Exposed bedrock made up more than 75% of the substrate observed at four 1 m locations, extending from the area between the Bruce GS 'B' intake transect and South Boundary Point to Inverhuron Bay. Within that portion of shoreline the location between South Boundary Point and Holmes Bay was dominated by boulder-cobble, while the substrate midway between the Gunn Point and Inverhuron Bay transects was covered entirely by sand. The two 1 m locations south of Inverhuron Bay had a mixture of exposed bedrock, boulder-cobble and pebble-gravel. The two locations in the northern portion of the site, at 5 and 7 m, were dominated by bedrock and boulder-cobble.

Further sampling is scheduled during 1982 at points missed during 1981. A description and evaluation of the combined results will be included in the 1982 report.

3.1.2 Sedimentation

Sedimentation rates were determined from material collected in sediment traps over three sampling periods (May-July, July-September, September-November). This sampling gives an indication of the rate at which suspended material comes in contact with the substrate, but does not represent the accumulation of material, which is affected by currents and turbulence. Table 3.1-2 gives the total sedimentation rate ($g/cm^2/day$) and per cent loss-on-ignition, which is usually indicative of organic content. Separate presentation of inorganic and loss-on-ignition sedimentation rates, as included in previous reports, have been eliminated due to their redundancy. The inorganic and loss-on-ignition sedimentation rates are given in Appendix 2.

TABLE 3.1-1

MEAN SUBSTRATE COMPOSITION AT LOCATIONS SAMPLED IN 1981

Transect	Depth	Mean % Composition			
		Bedrock	Boulder-Cobble 64-500+mm	Pebble-Gravel 2-64 mm	Sand 0.125-2 mm
Between Lagoon Bay and Bruce GS 'B' Discharge	7 m	67	22	1	
Bruce GS 'B' Discharge	5 m	33	67		
Between Bruce GS'B' Intake and S. Boundary Point	1 m	83	8	9	
Between S. Boundary Point and Holmes Bay	1 m		81	19	
Between Holmes Bay and Gunn Point	1 m	96	4		
Gunn Point	1 m	100			
Between Gunn Point and Inverhuron Bay	1 m				100
Inverhuron Bay	1 m	99			1
Between Inverhuron Bay and McRae Point	1 m	41	30	28	
McRae Point	1 m	53	33	14	

TABLE 3.1-2

RESULTS OF SEDIMENT TRAP SAMPLING:
TOTAL SEDIMENTATION ($g/cm^2/day$) AND % LOSS-ON-IGNITION (LOI)

Depth (m)	Douglas Point		Lagoon Bay		Bruce 'B' Discharge		Bruce 'B' Intake		South Boundary Road		Holmes Bay		Gunn Point		Inverhuron Bay		McRae Point		Depth Means	
	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI	Rate	% LOI
MAY - JULY																				
3	0.0050	9.7	0.0048	9.9	0.0353	10.8	0.0042	9.9	0.0075	8.0	0.0040	7.8	0.0035	8.9	0.0031	9.3	0.1012	10.9	0.0187	9.5
7	0.0048	9.0	0.0055	7.0	0.0019	9.6	0.0042	6.1	0.0046	7.3	0.0054	10.8	0.0031	9.0	0.0050	7.5	0.0050	10.3	0.0044	8.5
12	-		0.0025	3.4	0.0028	5.2	0.0026	5.0	0.0018	7.7	-		0.0005	15.6	0.0017	7.6	0.0007	19.4	0.0018	9.1
Transect Means	0.0049	9.4	0.0043	6.8	0.0133	8.5	0.0037	7.0	0.0046	7.7	0.0047	9.1	0.0024	11.2	0.0033	8.1	0.0356	13.5		
JULY - SEPTEMBER																				
3	0.0128	8.1	0.0238	8.8	0.0504	7.4	0.0070	6.2	0.0082	6.6	0.0628	6.5	0.0108	6.0	0.0581	2.5	0.0307	5.3	0.0294	6.4
7	0.0135	7.2	-		0.0208	6.9	0.0254	4.6	-		0.0458	5.7	0.0164	5.8	0.1399	3.9	0.0225	5.6	0.0406	5.7
12	-		0.0201	6.6	-		0.0732	2.3	0.0139	5.7	-		0.0051	7.3	0.0088	4.3	0.0206	6.3	0.0236	5.4
Transect Means	0.0132	7.7	0.0220	7.7	0.0356	7.2	0.0352	4.4	0.0111	6.2	0.0543	6.1	0.0108	6.4	0.0689	3.6	0.0246	5.7		
SEPTEMBER - NOVEMBER																				
3	-		-		-		-		-		0.0274	3.4	-		-		0.1328	1.9	0.0801	2.7
7	-		-		-		-		-		-		-		-		0.3168	1.2	0.3168	1.2
12	-		-		0.0726	1.2	0.2991	1.5	-		-		-		-		0.0343	1.5	0.1353	1.4
Transect Means	-		-		0.0726	1.2	0.2991	1.5	-		0.0274	3.4	-		-		0.1613	1.5		

May - July

In the first sampling period the greatest amount of sedimentary material was collected along the 3 m depth contour ($\bar{X}$ = 0.0187 g/cm^2/day) with highest mean values at Bruce GS 'B' discharge (0.0353 g/cm^2/day) and McRae Point (0.1012 g/cm^2/day). The least material was collected along the 12 m depth contour ($\bar{X}$ = 0.0018 g/cm^2/day). Among transects, mean sedimentation rate ranged from 0.0024 g/cm^2/day at Gunn Point to 0.0356 g/cm^2/day at McRae Point.

Sampling locations with the highest percentage of loss-on-ignition sediment were McRae Point 12 m (19.4%) and Gunn Point 12 m (15.6%). Lowest values for per cent loss-on-ignition sediment were also found at 12 m locations: Bruce GS 'B' intake (5.0%), Bruce GS 'B' discharge (5.2%), and Lagoon Bay (3.4%). There did not appear to be any consistent spatial trends in per cent loss-on-ignition sediment.

July - September

During the second sampling period the greatest amount of sedimentary material was collected along the 7 m depth contour ($\bar{X}$ = 0.0406 g/cm^2/day). The least amount of material was collected along the 12 m depth contour (X = 0.0236 g/cm^2/day). Among transects, the mean sedimentation rate ranged from 0.0108 g/cm^2/day at Gunn Point to 0.0689 g/cm^2/day at Inverhuron Bay.

Sampling locations with the highest per cent loss-on-ignition sediment were Lagoon Bay 3 m (8.8%) and Douglas Point 3 m (8.1%). Locations with the lowest per cent loss-on-ignition sediment were Bruce GS 'B' intake 12 m (2.3%) and Inverhuron Bay 3 m (2.5%).

September - November

In the third sampling period samples were lost at the majority of locations due to strong wave action caused by high winds. Of the six locations where reliable samples were obtained, only one transect, McRae Point, was complete. Total sedimentation at this transect averaged 0.1613 g/cm^2/day with the majority (0.3168 g/cm^2/day) occurring at the 7 m depth.

Among the six locations, per cent loss-on-ignition sediment was highest at Holmes Bay 3 m (3.4%) and lowest at Bruce GS 'B' discharge 12 m and McRae Point 7 m locations (1.2%). Material lost on ignition contributed a relatively small proportion of total sedimentation during this period, when sediment accumulations were generally high.

Materials suspended by erosion of shorelines or tributary banks during storms would be expected to be primarily inorganic.

The accumulation of material in sediment tubes represents in large part the effects of repeated scouring and redeposition of silt and sand from shoreline and inshore areas during periods of strong wave action. Elevated sedimentation rates in some areas would be the results of nearshore current patterns. Excavation of the intake for Bruce GS 'B' could also have contributed to sedimentation. However, it cannot be determined to what extent construction activity was responsible for the relatively high rates of sedimentation at the Bruce GS 'B' intake 12 m location on the last two sampling periods. Consistent spatial trends in sedimentation were lacking, possibly due to seasonal differences in current patterns. Year-to-year differences in the timing of storms may determine, to a large extent, which period has highest sedimentation rates, as in 1980, Bruce GS 'B' sedimentation in July to September exceeded sedimentation in September to October.

3.1.3 Temperature, Oxygen and Transparency

Continuous Temperature Monitoring

Bottom temperatures in the vicinity of the Bruce GS 'B' discharge at 2.5 m depth were monitored from mid-May to mid-November, 1981 (Figure 3.1-1). Initial readings in mid-May were 5°C. Temperatures first reached 15°C in mid June, and 20°C in early July. Fluctuations in temperature during July and August were extreme, as temperatures ranging from 8°C to 23°C were recorded. Much of this fluctuation is presumed to be caused by storm-induced mass water movements such as upwellings. Such unstable inshore thermal regimes are typical for the area (eg Ontario Hydro Research Division Report Nos 76-343-K and 83-182-K). Intermittent influence from heated discharges of Douglas Point and BHWP to the north of the site may also have influenced the temperature regime with temperature elevations occasionally reaching from 2 to 3°C above ambient (Hydraulic Studies and Development Department Communication). A relatively steady decline in temperature from 20°C to 9°C occurred from mid-September to November.

Continuous temperature records approximately 1 km offshore at the same depth gave substantially similar information, except that they provided data from April 22 to May 15 and November 15 to December 4. Ambient temperatures as low as 2.7°C were recorded in late April (Appendix 3).

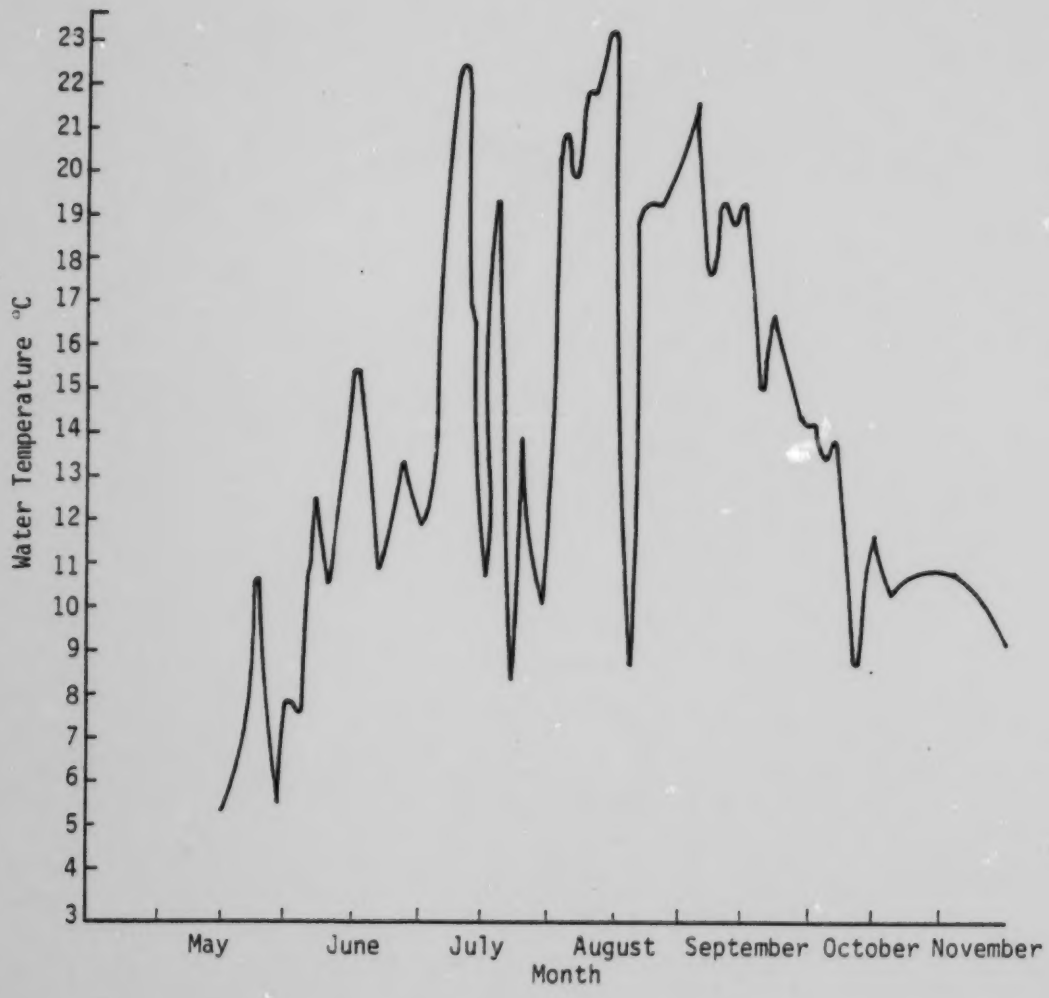


FIGURE 3.1-1

DAILY WATER TEMPERATURES AT 2.5 M DEPTH
NEAR BRUCE GSB, DISCHARGE MAY - NOV., 1981

Temperature and Oxygen Profiles

Temperature and oxygen profiles were obtained at 12 m depth near the Bruce GS 'B' intake location and Gunn Point, approximately monthly from July 9 to December 7. In addition, vertical temperature structure from approximately the 5 to 30 m contours was determined on four dates (June 2 to November 4) in conjunction with the acoustic fish census (Section 3.5.3). Temperature and oxygen profiles illustrating the full range of conditions are shown in Figure 3.1-2. All profiles are given in Appendix 4.

During most of the year temperatures to the 12 m depth were nearly isothermal, as the epilimnion extended below 12 m (July 9), or little or no stratification was present in the nearshore area (July 29, October 5 to December 7). On August 20 a moderate temperature gradient of 0.5 - 1°C/m was present between 2 and 12 m. By September 3 this had developed into a sharp thermocline at 12 to 20 m depth, with water at the intake depth again entirely within the epilimnion.

Dissolved oxygen values approximated the 100% air saturation values relative to temperature (Figure 3.1-2; Wetzel, 1975).

There was little difference between the Bruce GS 'B' intake and Gunn Point locations in either temperature or oxygen profiles.

Transparency

Values for transparency were obtained on the plankton sampling grid in July, August and October (Table 3.1-3). Over the site, transparency was highest on July 7, with Secchi depths ranging from 5.5 to 11.5 m and lowest on October 29, with Secchi depths from 3.5 to 7.8 m. In July and August a tendency for increasing transparency with distance from shore was observed. In July and October transparency increased from north to south. Low transparency (3.5 to 4.2 m Secchi depth) at 1500 to 2000 m from shore in the north end of the site in October suggested that material was being suspended by wave action from areas of the shoreline at some distance further north, and being carried offshore in a south-westerly direction.

Transparency data could not be correlated with sediment trap results, possibly because of the difference in time frame of sampling. Construction activities, which were limited to intake excavation, did not appear to have any effect on the transparency data, but, again, transparency sampling was infrequent and not timed to coincide with these activities.

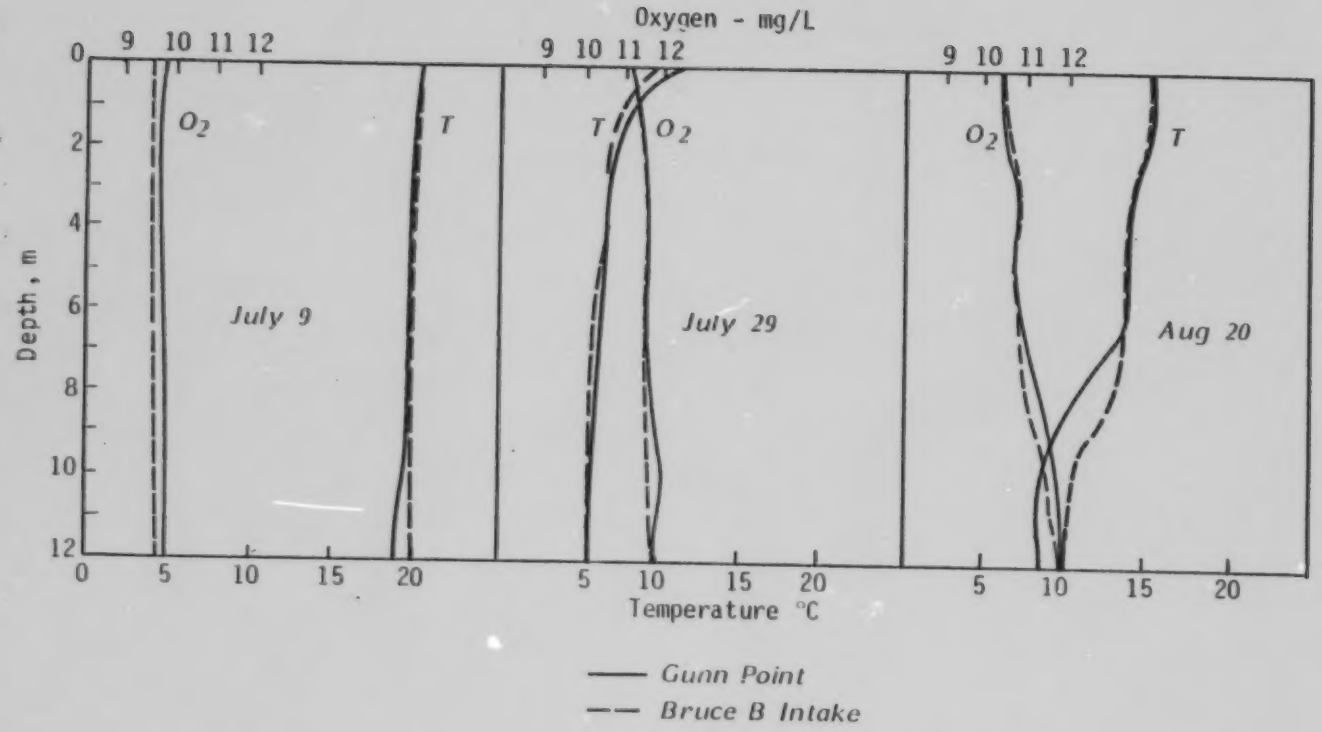


FIGURE 3.1-2

TEMPERATURE AND OXYGEN PROFILES AT BRUCE GSB
ON SELECTED DATES, 1981

TABLE 3.1-3

SECCHI DEPTHS (M) ON THE BRUCE GS 'B' PLANKTON GRID, 1981

Date	Distance from Shore (m)	(North) Location (South)						
		Douglas Point	Lagoon Bay	Bruce 'B' Discharge	Bruce 'B' Intake	South Boundary Rd	Holmes Bay	Gunn Point
July 7	500	6.3	5.6	6.8	5.5	6.5	8.4	6.5
	1000	6.3	5.5	9.7	8.3	7.8	8.7	8.0
	2500	5.8	7.9	9.2	10.0	10.1	9.5	10.0
	2000	7.5	9.5	10.3	9.0	10.7	11.0	11.5
August 12	500	6.0	5.5	6.0	5.5	5.5	5.5	5.5
	1000	6.5	6.0	5.5	6.5	6.5	7.5	6.5
	1500	7.5	7.0	7.0	7.0	7.0	8.0	7.0
	2000	8.5	8.5	9.5	8.0	8.5	9.0	9.0
October 29	500	5.3	5.0	7.8	5.5	7.0	5.5	5.3
	1000	4.8	5.0	5.0	7.0	6.0	7.0	5.5
	1500	3.8	5.0	4.0	7.0	6.0	7.5	6.0
	2000	4.0	3.5	4.2	5.5	5.5	5.0	6.0

3.2 Water Chemistry

Twenty-three chemical parameters were determined for water samples taken monthly on six dates from May 13 to November 10 (Table 3.2-1). Values obtained were generally consistent with those obtained in Lake Huron in other surveys (Ontario Hydro Research Division Reports 82-205-K and 82-107-K).

Water quality criteria (Ontario Ministry of the Environment, 1978, 1981) were available for some parameters examined, and observed levels were compared with the criteria. Dissolved solids (110-150 mg/L) and ammonia (<0.01 mg/L) were much lower than maximum levels for drinking water (<500 mg/L and 0.02 mg/L). Total phosphorus averaged approximately 9 µg/L, less than the 10 µg/L (average for the ice free period) specified as giving a high degree of protection from nuisance algal growth. The calcium-magnesium ratio (consistently 3.7:1) was within the range (3:1-5:1) expected for natural, unpolluted waters.

Few seasonal trends were apparent. There was some evidence of decreasing levels of nitrogen and phosphorus nutrients from spring to summer, possibly as they were taken up by expanding algal populations. Suspended solids were generally below the limit of detection in summer, and slightly lower pH values were measured in July and November, but the significance of these changes is unknown.

Water chemistry parameters were generally uniform spatially. One exception was the recurrence of consistently higher silica values in bottom water samples. This may have reflected the re-suspension of sediments close to the substrate. There were some large but inconsistent spatial differences in total phosphorus determinations in August and September. The significance of the high values is unknown. They may have been artifacts, as orthophosphorus and soluble phosphorus did not show corresponding peaks.

3.3 Attached Algae

Seventeen taxa of attached algae and three taxa of epiphytic algae were identified in the samples from the Bruce GS 'B' transects in 1981 (Table 3.3-1). Seven of the attached algal taxa and all of the epiphytes were found in 1979. Taxa present in 1981, but absent in 1979, included *Bulbochaete*, *Rhizoclonium* and *Calothrix;* all of which were common and dominant on at least one occasion. Conversely, *Chaetonema*, *Protoderma* and *Dicothrix* were common at some locations in 1979, but were absent in 1981. Due to taxonomic similarities between species such as *Rhizoclonium* and *Cladophora*, and *Calothrix* and *Dicothrix*

TABLE 3.2-1

BRUCE GS 'B' WATER CHEMISTRY, 1981

Parameter	Date																							
	May 13				June 17				July 22				August 27				September 28				November 10			
	Intake 12 m		Disch Surf		Intake 12 m		Disch Surf		Intake 12 m		Disch Surf		Intake 12 m		Disch Surf		Intake 12 m		Disch Surf		Intake 12 m		Disch Surf	
	Surf	Bottom	3 m	7 m	Surf	Bottom	3 m	7 m	Surf	Bottom	3 m	7 m	Surf	Bottom	3 m	7 m	Surf	Bottom	3 m	7 m	Surf	Bottom	3 m	7 m
Dissolved solids 105°C (mg/L)	126	123	124	128	126	112	117	122	-	121	124	117	156	150	140	144	108	118	118	110	108	111	130	135
Dissolved solids 550°C (mg/L)	106	99	101	107	97	80	90	90	-	97	102	101	120	114	106	114	88	86	90	84	89	93	91	93
Suspended solids 105°C (mg/L)	2.2	2.4	2.6	2.2	1.3	3.0	1.0	1.5	<1	5.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.0	2.3	3.7	2.0	2.4
Suspended solids 550°C (mg/L)	1.4	1.8	1.6	1.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.6	1.7	2.7	1.4	2.0
Turbidity (NTU)	1.0	1.2	1.1	1.1	1.0	1.1	1.1	1.3	0.8	1.6	1.3	0.8	0.4	0.4	0.6	0.3	1.5	1.7	1.8	1.8	1.8	1.7	1.8	1.8
pH	8.0	8.0	8.1	8.1	8.2	8.1	8.2	8.1	7.9	7.8	7.7	7.9	8.3	8.2	8.3	8.3	8.1	8.3	8.2	8.1	7.6	7.6	7.5	7.5
Specific conductance (mS/m)	20	20	20	20	18.3	18.1	18.2	18.7	18.5	18.2	19.0	18.0	18.5	18.5	19.0	18.8	19	19	20	19	18	18	17	19
Total phosphorus (µg/L as P)	8	8	<5	9	13	14	13	16	<5	8	10	5	21	7	<5	<5	9	19	9	7	5.4	6.1	4.0	9.0
Soluble phosphorus (µg/L as P)	<5	<5	<5	<5	7	13	7	6	<5	8	6	5	<5	<5	<5	<5	9	9	8	8	4.1	4.6	1.8	8.0
Particulate phosphorus (µg/L as P)	4-8	4-8	0-4	5-9	6	1	6	7	0-4	0	4	0	17-21	3-7	0-4	0-4	0	10	1	0	1.3	1.7	2.2	1
Ortho phosphorus (µg/L as P)	8	8	<5	9	5	12	6	9	<5	8	<5	<5	<5	<5	<5	<5	9	9	9	8	<5	<5	<5	6
Total Kjeldahl nitrogen (mg/L as N)	0.6	0.5	0.6	0.5	0.75	0.78	0.76	0.76	0.18	0.20	0.18	0.16	0.34	0.34	0.27	0.24	0.15	0.15	0.15	0.14	0.13	0.12	0.11	0.12
Soluble nitrogen (mg/L as N)	0.4	0.5	0.5	0.4	0.63	0.53	0.76	0.41	0.10	0.20	0.19	0.17	0.25	0.27	0.23	0.23	0.14	0.13	0.14	0.14	0.10	0.09	0.09	0.09
Nitrite nitrogen (mg/L as NO_2)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ammonia (mg/L as NH_3)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate nitrogen (mg/L as NO_3)	1.5	1.8	1.8	1.8	1.2	1.3	1.2	1.2	0.01	1.3	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2
Total silica as SiO_2 (mg/L)	1.62	1.62	1.46	1.49	1.49	1.88	0.92	1.28	1.57	1.87	1.99	1.58	1.22	1.48	1.30	1.26	1.67	1.58	1.33	1.13	1.37	1.69	1.16	1.05
Soluble silica as SiO_2 (mg/L)	1.52	1.52	0.82	1.04	0.86	1.01	0.79	0.77	1.01	1.22	1.07	1.07	0.98	1.07	0.98	0.98	1.20	1.24	1.13	1.07	0.66	0.66	1.01	1.01
Calcium (mg/L)	26.0	26.0	26.0	26.0	26.5	27.1	26.8	27.0	26.5	26.9	27.1	26.6	27	28	27	27	27	28	28	27	25	25	24	24
Magnesium (mg/L)	7.0	6.9	6.9	6.8	6.9	7.0	6.9	7.1	7.2	7.3	7.4	7.3	7.2	7.2	7.1	7.1	7.1	7.1	7.1	7.0	7.2	7.1	7.0	7.0
Chlorophyll a (µg/L)	<0.5	<0.5	<0.5	<0.5	2.1	1.8	1.8	2.1	1.1	1.1	1.4	0.6	<0.5	<0.5	<0.5	<0.5	1.4	1.6	1.6	1.7	1.5	1.0	1.0	1.3
Chemical Oxygen Demand (mg/L)	<5	<5	<5	<5	<5	7	7	14	<5	<5	<5	6	<5	6	<5	<5	6	<5	<5	7	<5	<5	<5	<5
Biological Oxygen Demand (mg/L)	1.0	1.0	2.0	1.0	1.1	1.2	0.8	0.9	0.7	1.2	0.7	0.6	0.7	1.2	0.7	0.6	1.0	1.1	1.0	-	2.1	1.2	1.3	-
Colour	None found in any sample.																							

83-451

TABLE 3.3-1

MEAN % COMPOSITION OF THE ATTACHED ALGAE SAMPLES - BRUCE GS 'B' - 1981
Samples Containing Detritus Only Were Omitted During Averaging;
0 = no algae; + = present; s = shore

Month	June																August																October													
Location	Douglas Point		Lagoon Bay		Bruce 'B' Discharge		Bruce 'B' Intake		South Boundary		Holmes Bay		Gunn Point		Douglas Point		Lagoon Bay		Bruce 'B' Discharge		Bruce 'B' Intake		South Boundary		Holmes Bay		Gunn Point		Douglas Point		Lagoon Bay		Bruce 'B' Discharge		Bruce 'B' Intake		South Boundary		Holmes Bay		Gunn Point			
Species / Depth	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m	S	3 m		
Attached Algae																																															
Chlorophyta										0	0																																			
Bulbochaete																	38				75		37	71	48		47	33		33		30				65	1		43		40	20		
Cladophora glomerata															65				20					29																				
Cladophora sp																																									1					
Coleochaete																											5																		
Draparnaldia																									7																				
Mougeotia		31						20							4	60	30	67		17	12	23	37	40	4	53	12	17		27		48		18	5	23	10	15		38	13	7		
Oedogonium															13										3					5									1		7			
Rhizoclonium																														15		17		82		12	8	65	15	13		7		
Spirogyra																	21		41			68		13	1	40																		
Stigeoclonium					15										15		20								25				1		3		1		3		5						
Rhoithia sp	100															10		1							1				36		43		68		13		5		33				
Rhoithia zonata		33	100		85		100	80	100				10	100	1		12	7	100			8			11		7	23	40	12		48		13		13		17		3				
Zygnema		33		100		100							90			30	12	7		20		8		1		7	23	40		13		5		63		8	10			13			
Cyanophyta																																													
Calothrix																					13		27		1		13			7	5		17				43		3	20	27	66		
Cylindrospermum																													51																
Plectonema																											10																		
Schizothrix																																						10		8					
Epiphytes																																													
Chrysophyta																																													
Cocconeis								+							0									1																					
Cymbella	+	+	+	+		+	+	+					+		0	+	+	+		+	+	+	+	+	+	+	+		+			+	+	+	+	+	+	+	+	+	+			
Rhizosolenia sp		+	+		+				+				+		+																													

(Prescott 1962), it is likely that some of the changes in species between 1979 and 1981 represent difficulties in the identification of depauperate or sterile material rather than true shifts in species composition.

Shoreline Samples

Ulothrix was the only alga found at all shoreline sampling locations in June, except Holmes Bay where no algae were found and the Bruce GS 'B' discharge location where *Stigeoclonium* was found in addition to *Ulothrix*. This is consistent with observations made in 1979 when *Ulothrix* was the most common species in June.

Ulothrix persisted as the dominant genus at the Bruce GS 'B' discharge in August, but was replaced by *Cladophora glomerata*, *Bulbochaete* or *Bulbochaete* and *Mougeotia* at the remaining locations. The water temperature in the Bruce GS 'B' discharge location on the day of sampling was 20°C (ambient), a temperature considerably higher than the 10 - 15°C reported as maximal for *Ulothrix* growth in other areas (Taft 1975, Rosemarin 1980, Kirby and Dunford 1981). The decreased abundance of *Ulothrix* from June to August at the remaining Bruce GS 'B' shoreline sample sites is, however, consistent with the reported thermal tolerance range of the species. Water temperatures at these locations on the August sampling date ranged from 20°C to 24.5°C (Appendix 5A).

Bulbochaete remained the dominant genus in October at Holmes Bay and Gunn Point, but was replaced by *Ulothrix* at Douglas Point and Lagoon Bay. *Zygnema* became prominent at the Bruce GS 'B' intake and *Cylindrospermum* at South Boundary. Little change occurred at the Bruce GS 'B' discharge location where *Ulothrix* continued to dominate the attached algae.

The general temporal shift in 1981 from *Ulothrix* to *Bulbochaete* to *Ulothrix* differs from that observed in 1979 (Ontario Hydro Research Division Report 82-229-K) when there was a tendency for *Ulothrix* to dominate in June and *Mougeotia* in October. The algae were sparse in August 1979 due to severe storms which preceded sampling. The reasons for the temporal differences between 1979 and 1981 are not known. Information is lacking on the conditions that lead to replacement of one attached algal species by another.

3 m Attached Algae

Zygnema was either the dominant or a co-dominant at the 3 m depth at all locations in June except the Bruce GS 'B' intake transect where *Ulothrix* was dominant and South Boundary where

algae were absent. *Mougeotia* became dominant at all locations in August except Gunn Point where *Zygnema* persisted as the dominant and the Bruce GS 'B' intake and discharge transects where *Spirogyra* was the most common species.

October dominants included *Bulbochaete* and *Mougeotia* at Douglas Point, Lagoon Bay and the Bruce GS 'B' intake, *Rhizoclonium* at the Bruce GS 'B' discharge, South Boundary and Holmes Bay and *Calothrix* at Gunn Point. *Rhizoclonium* was co-dominant with *Mougeotia* in October at Holmes Bay.

These trends again differ for unknown reasons from 1979 (Ontario Hydro Research Division Report 82-229-K) when no algae were found in June and *Mougeotia* was the most common species in August and October.

Epiphytes

Of the three epiphytic genera found in the 1981 Bruce GS 'B' samples, *Cymbella* was the most common occurring in every month at both the shore and 3 m depths at most locations.
Like *Cymbella*, *Rhicosphenia curvata* did not evidence a spatial trend, but was more common in June than at any other time. *Cocconeis* occurred only infrequently. These observations are consistent with those from the Bruce GS 'A' 1981 survey (Ontario Hydro Research Division Report No 83-96-K) but differ from those evident in the Bruce GS 'B' 1979 survey (Ontario Hydro Research Division Report 82-229-K). In 1979 six epiphytes were identified, including those found in 1981. *Cymbella* was common in 1979 as were *Pennales* and *Gomphonema*.

Biomass

The ash-free dry weights of the samples collected at the shoreline and 3 m depths are given in Appendix 5. Many of the samples from June and October consisted entirely or mainly of detritus and the weights obtained overestimate attached algal biomass. The samples range in weight from 0 g/m^2 to 63.9 g/m^2. Maximum monthly mean weights for the shore (41.1 g/m^2) occurred at Lagoon Bay in June and for the 3 m depth (25.1 g/m^2) at the Bruce GS 'B' discharge in June (Figure 3.3-1). The range in ash-free dry weights in 1981 is similar to that observed in 1979 (Ontario Hydro Research Division Report 82-229-K).

In order to examine the data for differences between stations, depths and months, a three-way ANOVA was computed following transformation to a natural logarithmic scale. The transformation was required to meet with the assumption of ANOVA of homogeneity of variance (Snedecor and Cochran 1967). Samples with no or sparse algae were assigned a zero weight prior to the

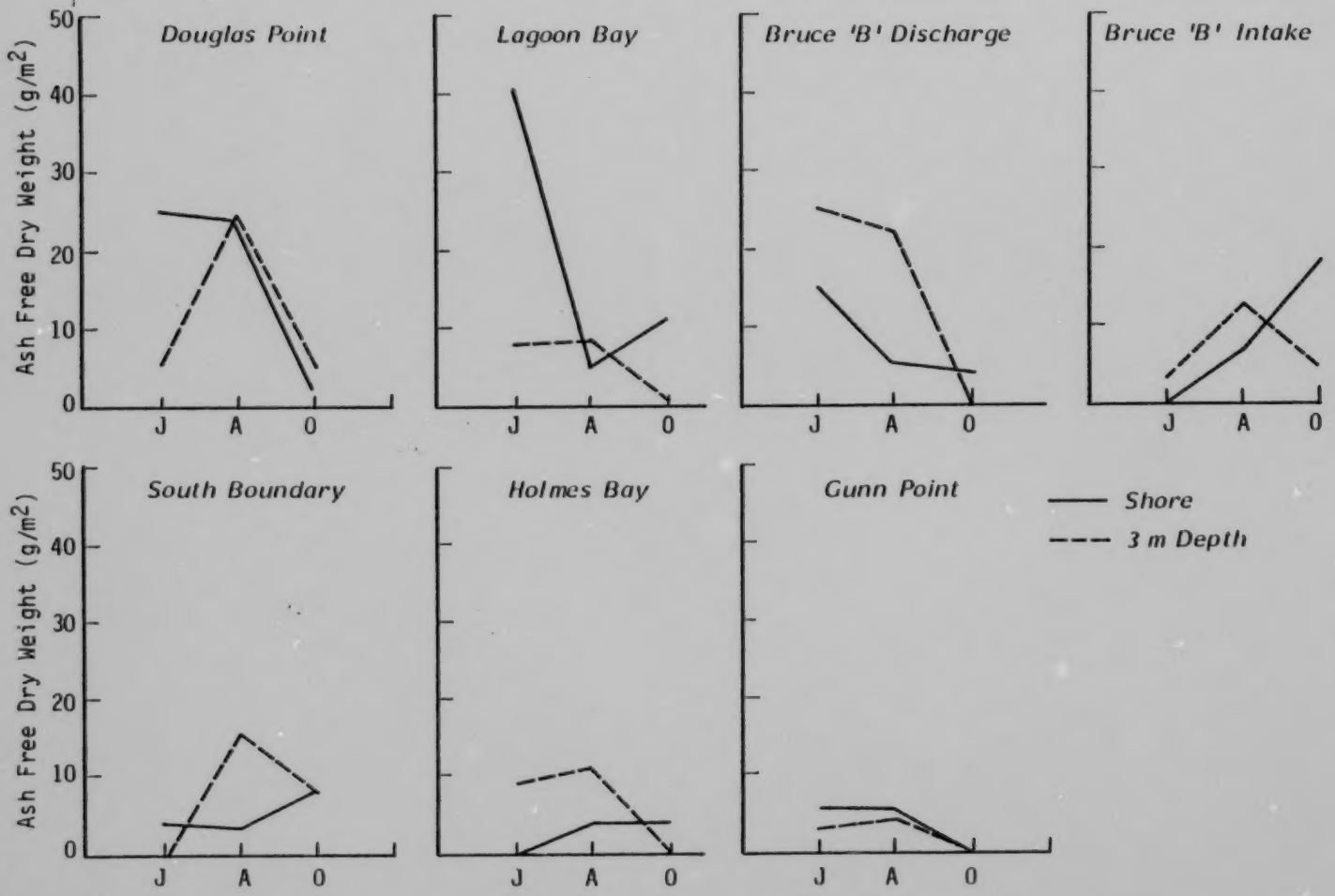


FIGURE 3.3-1

MONTHLY MEAN ASH FREE DRY WEIGHT OF ATTACHED ALGAL SAMPLES - BRUCE GS 'B' - 1981
SAMPLES WITH NO OR SPARSE ALGAE WERE ASSIGNED A ZERO WEIGHT BEFORE AVERAGING

161207 RD

ANOVA. Although the remaining samples contained some detritus, which introduce an error into the analysis, the error was small since the samples consisted primarily of algae.

The three-way interaction term (station x depth x month) was significant at the 95% level ($F = 4.42$; 12, 84) indicating that the seasonal trend of algal growth was not uniform across stations or depths. This is not an unexpected result given the diverse patterns in the mean monthly biomass evident in Figure 3.3-1. As a consequence of the interaction, no overall statement can be made concerning the differences between stations, between depths or between months.

3.4 Zoobenthos

Community Composition

The zoobenthic community was sampled by vacuum dome during two periods: June 11 to July 29, and October 29 to November 3. For all samples combined, a mean density of approximately 1200 organisms/m^2 was obtained (Table 3.4-1). Oligochaetes (55%) and dipteran larvae (41%) contributed a far larger proportion of the benthic community than any other major taxonomic group. Dominance of the benthos by oligochaetes was also observed in 1979, when they contributed 66% of the organisms at Bruce GS 'B' (Ontario Hydro Research Division Report 82-229-K).

TABLE 3.4-1

COMPOSITION OF ZOOBENTHOS BY MAJOR TAXONOMIC GROUP

Taxonomic Group	Mean Density No/m^2	% Composition
Oligochaeta	659	55.7
Diptera	489	41.3
Acarina	22	1.8
Tricoptera	6	0.5
Ephemeroptera	5	0.4
Mollusca	3	0.3
Amphipoda	1	0.1
TOTAL	1185	

The total number of taxa identified was 61, with 29 separated at the species level. Five taxa, including three oligochaete and two dipteran taxa, contributed 5% or more to the organisms sampled (Table 3.4-2). The most numerous organisms were the oligochaetes *Nais simplex* (27%) and *Nais pardalis* (15%). This differed somewhat from the observed composition at the Bruce GS 'B' study area in 1979, when *Nais pardalis* contributed over 50% of the organisms collected.

Spatial and Temporal Variation in Community Composition

The distribution of measures of zoobenthic diversity is given in Table 3.4-3. The number of taxa was considered indicative of faunal richness, while the Shannon-Wiener diversity index was considered indicative of evenness (lack of dominance). The higher mean number of taxa (8.7) and diversity index (2.3) were found in the June 11 - July 29 period. Diversities of the six samples whose collection was delayed to July 29 were apparently not different from the balance of the samples which were collected in June.

Among transects, the mean numbers of taxa (8.8) and mean diversity indices (2.2) were greatest at Holmes Bay during both sampling periods. Among depth contours, numbers of taxa and diversity indices were relatively low at the 12 m depth during both sampling periods. Numbers of taxa and diversity indices at 1 m locations were conspicuously low in October, with the exception of Holmes Bay. No other spatial trends in zoobenthic diversity were observed.

The temporal difference in diversity observed in 1981 was the reverse of that observed in 1979. This was probably due to the difference in timing of storms producing large-scale disturbance in the nearshore zone. In October the 1 m locations, which are the most vulnerable to wave action, all had relatively low diversity with the exception of Holmes Bay, which is somewhat protected. Holmes Bay had the highest mean diversity in both years. A second factor which may promote species diversity at Holmes Bay (1 m) and is correlated with the lessened exposure to wave action is the somewhat smaller and more heterogeneous substrate (Table 3.4-4) which should afford a greater variety of microhabitats.

Mutual Information Analysis was used to group the zoobenthic collections on the basis of species dominance. Two groups with strongly dominant species were identified (Figure 3.4-1). Both were species of *Nais: N. simplex* (group 1) and *N. pardalis* (group 2). Group 1 was split into three sub-groups (1, 1a, 1b) which had three different species of *Nais* as the second most

TABLE 3.4-2

COMPOSITION OF ZOOBENTHOS BY INDIVIDUAL TAXA

	Taxon	% Contribution	Mean Density No/m^2	Frequency of Occurrence
O	*Nais simplex*	27.94	330.5	23
O	*Nais pardalis*	15.04	177.8	22
D	*Pseudosmittia* spp	6.04	71.4	25
O	*Nais variabilis*	5.91	70.3	39
D	*Cricotopus (cricotopus) cyl.*	5.81	68.6	35
D	Orthocladiinae	4.50	53.1	23
D	*Paratanytarsus* sp 1	3.51	41.5	24
D	*Tanytarsus* sp 2	3.14	37.1	21
D	*Cricotopus (isocladius)*	2.67	31.6	12
D	*Thienemannimyia* group	2.48	29.3	19
O	*Nais pseudoptusa*	2.34	27.7	1
D	*Parakiefferiella* spp	2.15	25.5	24
O	*Nais elinguis*	2.11	24.9	10
A	Acarina	1.83	21.6	8
D	*Orthocladius* sp A	1.64	19.5	2
D	*Dicrotendipes* T4	1.59	18.8	15
D	*Cricotopus (cricotopus)* est	1.08	12.7	10
D	*Pseudochironomus* spp	0.94	11.1	14
D	*Psectrocladius* spp	0.94	11.1	8
O	*Chaetogaster* spp	0.94	11.1	5
O	Tubificidae	0.84	10.0	10
D	*Tanytarsus* sp 1	0.75	8.9	10
D	*Paratanytarsus* spp	0.75	8.9	6
D	*Cricotopus* spp	0.75%	8.9	5
D	*Orthocladius* cf roback I	0.52	6.1	5
T	*Hydroptila* spp	0.37	4.4	5
D	*Cicrotendipes* spp	0.28	3.3	6
E	*Caenis* spp	0.28	3.3	4
D	*Tanytarsus* spp	0.23	2.8	4
O	*Vejdovskyiella comata*	0.23	2.8	3
D	Tanytarsini	0.19	2.2	4
D	*Potthastia* spp	0.19	2.2	3
D	*Procladius* spp	0.14	1.7	2
D	*sectrocladius* nr *simula*	0.14	1.7	2
O	*Slavina appendiculata*	0.14	1.7	3
D	*Heterotrissocladius* cf c	0.14	1.7	1
M	Gyraulus spp	0.09	1.1	1
D	*Heterotrissocladius* spp	0.09	1.1	2
D	*Cicrotendipes* T1	0.09	1.1	1
D	*Cladotanytarsus* spp	0.09	1.1	1
D	Chironomini	0.09	1.1	1
T	*Hydropsyche* spp	0.09	1.1	1
M	*Lymnaea catascopium*	0.09	1.1	2
D	*Stempellinella* sp 1	0.09	1.1	2
O	*Stylaria lacustris*	0.09	1.1	1
D	*Paratanytarsus* sp 2	0.09	1.1	1
D	*Xenochironomus* spp	0.09	1.1	1
D	*Synorthocladius* spp	0.05	0.6	1
D	*Thienemanniella* T2	0.05	0.6	1
D	*Paratendipes* spp	0.05	0.6	1
D	*Potthastia* sp 3	0.05	0.6	1
M	*Physa* spp	0.05	0.6	1
E	*Stenonema* spp	0.05	0.6	1
M	*Lymnaea* spp	0.05	0.6	1
O	*Nais* spp	0.05	0.6	1
D	*Parachironomus* T1	0.05	0.6	1
D	*Paracladopelma undine*	0.05	0.6	1
D	*Chironomus* spp	0.05	0.6	1
D	*Corynoneura* sp 2	0.05	0.6	1
E	*Ephemerella* spp	0.05	0.6	1
H	*Hyalella azteca*	0.05	0.6	1
		100.00	1185	

Abbreviations for Major Groups:

O - Oligochaeta, D - Diptera, A - Acarina, T - Tricoptera, E - Ephemeroptera, M - Mollusca, H - Amphipoda

TABLE 3.4-3

DIVERSITY OF ZOOBENTHIC COLLECTIONS AT BRUCE GS 'B', 1981
NO OF TAXA AND SHANNON-WEINER DIVERSITY INDEX

Date	Depth Contour (m)	Douglas Pt (A)		Lagoon Bay (B)		Bruce 'B' Discharge (C)		Bruce 'B' Intake (D)		South Boundary (E)		Holmes Bay (F)		Gunn Point (G)		Depth Mean	
		No of Taxa	Diversity Index	No of Taxa	Diversity Index	No of Taxa	Diversity Index	No of Taxa	Diversity Index	No of Taxa	Diversity Index	No of Taxa	Diversity Index	No of Taxa	Diversity Index	Mean No Taxa	Mean Diversity Index
June 11	1	13	1.85	10	2.45	5	2.20	8	2.67	15	2.39	26	3.29	16	2.20	13.3	1.437
to	3	4	1.66	6	2.46	9	1.51	8	2.76	7	2.72	2	1.00*	8	2.66*	6.3	2.110
July 29	7	5	2.12	11	3.13	10	3.34	10	2.80	11	3.07	9	2.82*	9	2.90*	9.3	2.883
	12	0	0	0	0	11	3.26	5	2.04	6	2.50	14	3.66*	5	2.24*	5.9	1.957
Transect Mean		5.5	1.408	6.8	2.01	8.8	2.578	7.8	2.570	9.8	2.670	12.8	2.693	9.5	2.500	8.7	2.347
October 29	1	5	1.39	6	1.90	2	1.00	5	1.51	1	0.00	13	2.17	4	1.92	5.1	1.570
to	3	6	2.40	8	2.63	15	2.99	7	2.59	9	2.65	16	3.38	1	0.00	8.9	2.377
November 3	7	9	2.82	2	0.92	6	1.95	14	3.38	7	2.66	1	0.00	18	3.43	8.1	2.166
	12	5	2.13	3	1.59	5	2.25	0	0	5	2.25	5	2.25	7	2.73	4.3	1.886
Transect Mean		6.3	2.185	4.8	1.760	7.0	2.048	6.5	1.870	5.5	1.890	8.8	2.225	7.5	2.020	6.6	2.000

* Samples collected July 29

TABLE 3.4-4

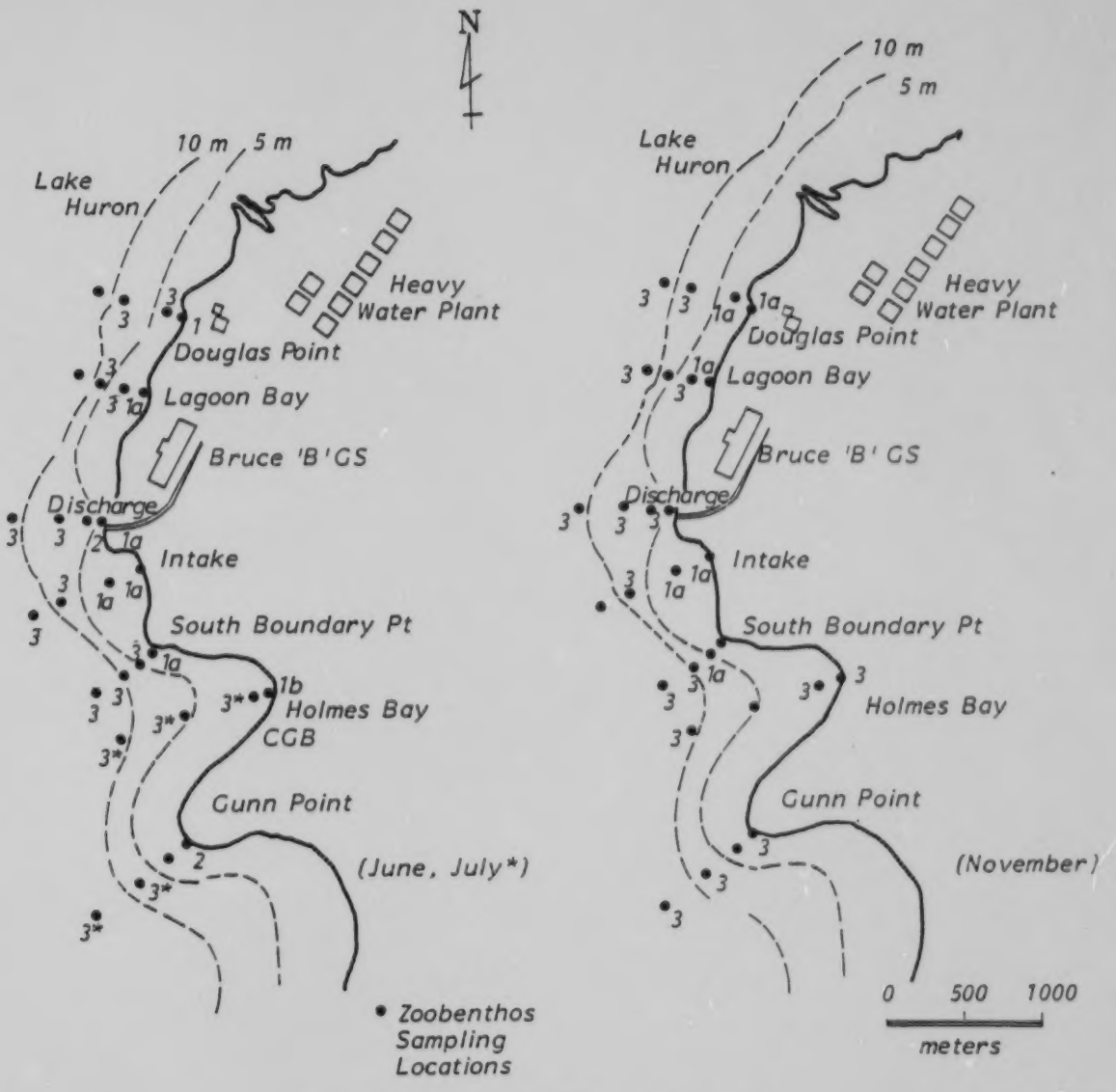
SUMMARY OF DIVERS' OBSERVATIONS AT ZOOBENTHOS SAMPLING LOCATIONS

Date	Depth Contour (m)	Location						
		Douglas Pt	Lagoon Bay	Bruce 'B' Disch	Bruce 'B' Int	S. Boundary Rd	Holmes Bay	Gunn Point
June to July	1	50% BEDR 50% BOLD 30% FILA	 95% BEDR 30% BRA	 100% ARM 80% FILA	80% BOLD 20% COB	90% BEDR 10% BOLD	70% COB 25% PGR 100% BRA	90% BEDR 10% BOLD
	3	60% BEDR 40% BOLD 100% BRA	90% BEDR 10% BOLD 100% BRA	 100% BOLD 100% BRA	 100% BEDR 100% BRA	90%BEDR 10% BOLD 100% BRA	10% BEDR 80% BOLD 10% COB SILT	 100% BEDR 100% BRA
	7	70% BOLD 15% COB 15% PGR 100% BRA	 95% BEDR 100% BRA	 95% BEDR 100% BRA	10% BEDR 40% BOLD 40% COB 10% PGR 100% BRA	40% BEDR 50% BOLD 100% BRA	40% BEDR 60% BOLD SILT	80% BOLD 20% COB 100% BRA
	12	10% BEDR 45% BOLD 45% COB 100% BRA	10% BEDR 90% BOLD 100% BRA	 100% BOLD 	 100% BOLD 	50% BEDR 50% BOLD 	35% BEDR 65% BOLD SILT	60% BOLD 40% COB 70% BRA
October to November	1	 100% BEDR 100% BRA	 100% BEDR 100% BRA	 100% BOLD 100% BRA	 100% BEDR 100% BRA	 100% BEDR 100% BRA	20% BOLD 40% COB 40% PGR 100% BRA	 100% BEDR 100% BRA
	3	50% BEDR 50% BOLD 100% BRA	90% BEDR 105% BOLD 100% BRA	 100% BOLD 100% BRA	 95% BEDR 100% BRA	 100% BEDR 100% BRA	50% BOLD 25% COB 25% PEB 100% BRA	 100% BEDR 100% BRA
	7	60% BEDR 30% BOLD 100% BRA	80% BEDR 20% BOLD 100% BRA	80% BEDR 20% BOLD 100% BRA	80% BOLD 10% COB 10% PGR 100% BRA	40% BEDR 40% BOLD 10% COB 10% PGR 100% BRA	10% BOLD 90% SAND 10% BRA	50% BOLD 40% COB 10% PGR 100% BRA
	12	50% BEDR 20% BOLD 30% COB 100% BRA	10% BEDR 90% BOLD 100% BRA	90% BEDR 10% BOLD 100% BRA	 100% BOLD 100% BRA	50% BEDR 40% BOLD 100% BRA	20% BOLD 10% COB 10% PGR 60% SAND 40% BRA	60% BOLD 20% COB 20% PGR

% is % of area sampled covered by this material (not shown if <10%)

ABBREVIATIONS

BEDR	Exposed Bedrock	ARM	Armour Stone
BOLD	Boulders (>25 cm)	FILA	Filamentous Algae, 3 or more
COB	Cobble (6 - 25 cm)	BRA	Short Brown Algae and Detritus
PGR	Pebble-Gravel (0.2 - 6 cm)	SILT	Unusually Heavy Silt Cover



Mean Percent Composition of Groups

Taxa	1	1a	1b	2	3
Nais simplex	54.07	36.97	38.34	8.96	5.96
N. pardalis	28.49	9.11	2.08	64.73	5.58
N. variabilis	6.68	16.10	2.31	9.41	2.10
N. pseudoptusa	0.00	0.00	11.55	0.00	0.00
Pseudosmittia spp	0.00	3.94	0.00	0.00	12.99
Cricotopus (Cr) cylandraceus	0.00	10.98	4.85	2.01	12.15
Orthocladinae	0.29	0.27	2.77	1.74	7.37
Parakiefferiella spp.	0.00	0.00	0.46	0.27	7.74
Tanytarsus sp 2	0.29	1.03	0.69	3.47	7.17

FIGURE 3.4-1

DISTRIBUTION AND COMPOSITION OF ZOOBENTHIC GROUPS AT BRUCE GS B, 1981

abundant species. A third sample grouping contained no clear dominant, but appeared to be a meaningful grouping in that it contained relatively few *Nais* and a large proportion of chironomids. This grouping also contained eight samples of fewer than three organisms. The latter were eliminated to produce group 3, in which the five most abundant chironomids collectively accounted for 47% of the organisms.

Sample groups dominated by species of *Nais* (*N. simplex*, groups 1, 1a, 1b, and *N. pardalis*, group 2) were distributed along the entire shoreline at depths of 1 and 3 m. Of these, only subgroup 1a, which had the greatest mean contribution by chironomids, was present in the fall. Sample group 3, which was dominated by chironomids (collectively), was prevalent at the 7 and 12 m depths in both months. It also occurred at 3 m locations in June-July, and at 3 and 1 m locations in October-November. No consistent associations were apparent between substrate and algal cover (Table 3.4-4) and the distribution of the groups identified by the Mutual Information Analysis. This may have been due in part to the very coarse substrates (bedrock and boulder) and the thin algal, detritus covering found at most locations. At the Bruce GS 'A' site (1979; Ontario Hydro Research Division Report 82-107-K) it was possible to relate species assemblages to both depth and substrate particle size, but medium-to-fine substrates occur with much greater frequency in the area north of Douglas Point.

Spatial and Temporal Variation in Zoobenthic Densities

The density distributions of the five most abundant taxa and all taxa combined are summarized in Tables 3.4-5 (a) and (b). For all taxa combined, the seasonal mean density (Table 3.4-5(a)) was considerably higher in June-July (1692 organisms/m^2) than in October-November (672 organisms/m^2). This is the reverse of the seasonal difference in abundance seen in 1979.

Spring-to-fall changes in densities of individual taxa included 5 to 10-fold decreases in the abundance of *Nais simplex* and *N. pardalis*, which were offset by a 10-fold increase in the abundance of *Pseudosmittia*. It is possible that the fall decrease in zoobenthic density, and in particular the density of *Nais*, was due to increased disturbance of the nearshore bottom by wave action. However, one would then expect *Nais* to be relatively more persistent in partially protected Holmes Bay, but this did not occur. Differences in species composition between the two years cannot account for the discrepancy in seasonal patterns, since the dominant species in 1979, *Nais pardalis*, was far more abundant in October in 1979 and far more abundant in June-July in 1981. The reasons for the seasonal and year-to-year changes in zoobenthic density are unclear at this time.

TABLE 3.4-5

DISTRIBUTION OF ZOOBENTHIC DENSITIES AT BRUCE GS 'B', 1981

(a) Depth Contour and Season Mean Densities - No/m^2

Months	Taxa	Depth Contour				Season Mean
		1	3	7	12	
June-July	*Naia simplex*	2901	58	84	9	763
	Naia pardalis	1063	230	27	22	335
	Naia variabilis	248	53	53	13	92
	Pseudoamittia spp	4	35	22	9	18
	Cricotopus cr *cyl*	190	44	102	22	90
	All Taxa	5164	593	686	323	1692
October - November	*Naia simplex*	279	58	44	4	96
	Naia pardalis	18	80	0	0	24
	Naia variabilis	59	89	27	0	44
	Pseudoamittia spp	31	270	177	22	125
	Cricotopus cr *cyl*	66	62	71	22	55
	All Taxa	655	1023	823	186	672

(b) Transect Mean Densities - No/m^2

Months	Taxa	Douglas Pt	Lagoon Bay	Bruce 'B' Disch	Bruce 'B' Int	S. Boundary Rd	Holmes Bay	Gunn Point
June-July	*Naia simplex*	1450	194	31	171	512	1287	279
	Naia pardalis	791	93	333	78	109	93	853
	Naia variabilis	178	70	93	101	39	109	109
	Pseudoamittia spp	0	0	0	0	8	8	54
	Cricotopus cr *cyl*	31	54	39	171	93	171	70
	All Taxa	2806	752	760	798	1194	3713	1822
October - November	*Naia simplex*	271	124	0	109	78	31	62
	Naia pardalis	23	8	85	47	0	8	0
	Naia variabilis	78	23	0	16	77	47	47
	Pseudoamittia spp	70	62	287	78	39	202	140
	Cricotopus cr *cyl*	147	85	16	47	31	8	54
	All Taxa	721	419	752	605	388	992	829

Trends in zoobenthic density with depth were seen in both months, but were better defined in June-July. In that month densities of zoobenthos, all taxa combined, were an order of magnitude higher at 1 m (5 164/m^2) than at the remaining depths. This did not hold in October-November, when fewer organisms were found at 1 m than at 3 or 7 m. In both months fewest organisms (<400/m^2) were found at 12 m. The only difference among depths which was statistically significant at the 5% level was between the 1 m and 12 m depths in June (two-way ANOVA; Student, Neuman, Keuls Test, Appendix 6).

The peak in overall density at the 1 m depth in June-July largely reflected the distribution of *Nais* species. Of the most numerous chironomid taxa, only *Pseudosmittia* was more abundant at intermediate depths. In contrast, in October only *Nais pardalis* was most abundant at 1 m, and the other four abundant taxa were most abundant at intermediate depths. In October-November, increased wave action and a lower water level may have contributed to the decline in the relative importance of the 1 m depth for zoobenthos.

Zoobenthic densities, all taxa combined, did not vary as strongly among transects as among depths (Table 3.4-5(b)). The relatively protected Holmes Bay transect had the highest density in both months (3713 and 992 organisms/m^2), which differed from 1979, when much larger numbers of organisms were collected on several other transects. The differences in density among transects were not statistically significant (Appendix 6).

In June-July *Pseudosmittia* spp was only taken from South Boundary Road to Gunn Point. Otherwise there were no strong alongshore trends or unique areas of concentration among the five most abundant species.

3.5 FISH

3.5.1 Ichthyoplankton

Species Composition

Plankton tows conducted from May 14 to August 6 produced a total of 6983 larval fish representing 15 taxa (Table 3.5-1; Appendix 11). The majority of these were rainbow smelt (76%) and alewife (12%). Johnny darter, burbot and unidentified cyprinids each contributed 2 - 3% of the catch. Only two salmonid larvae, one round whitefish and one cisco, were taken. The single round whitefish was a 9 mm larva taken at Lagoon Bay, 3 m contour (surface tow) on May 14.

TABLE 3.5-1

SPECIES COMPOSITION OF LARVAL FISH
TAKEN AT BRUCE GS 'B', MAY 14 TO AUGUST 6, 1981

Species	No Caught	%
Rainbow Smelt*	5361	76.8
Alewife	869	12.4
Johnny Darter	239	3.4
Burbot	168	2.4
Trout-perch	48	0.7
Slimy Sculpin	21	0.3
Yellow Perch	19	0.3
Deepwater Sculpin	8	0.1
White Sucker	3	<0.1
Carp	2	<0.1
Logperch	1	<0.1
Cisco	1	<0.1
Round Whitefish	1	<0.1
Unidentified Cyprinids	239	2.4
Unidentified Sculpins	3	<0.1
TOTAL	6983	

* A list of common and scientific names of all fishes caught is given in Appendix 9A.

Temporal Changes in Abundance and Size

The temporal changes in abundance of rainbow smelt, alewife and burbot are shown in Figure 3.5-1. Smelt were most abundant at the start of sampling on May 14 -20, (3300 fish/1000 m^3 in surface tows). By June 23 they declined to less than one fish per 1000 m^3. Larval alewife first appeared in very low numbers on June 23. There appeared to be two peaks in abundance, the first being on July 7 (170 fish/1000 m^3), and the second on August 6 (340/1000 m^3). The decline in alewife abundance on July 23 coincided with a cold-water upwelling (Figure 3.5-1).

Smelt larvae taken in May had mean total lengths of 6.1 - 6.3 mm (Table 3.5-2, Appendix 8) and thus were recently emerged . Mean length increased to 14 mm by June 23, although by this time nearshore densities were insignificant.

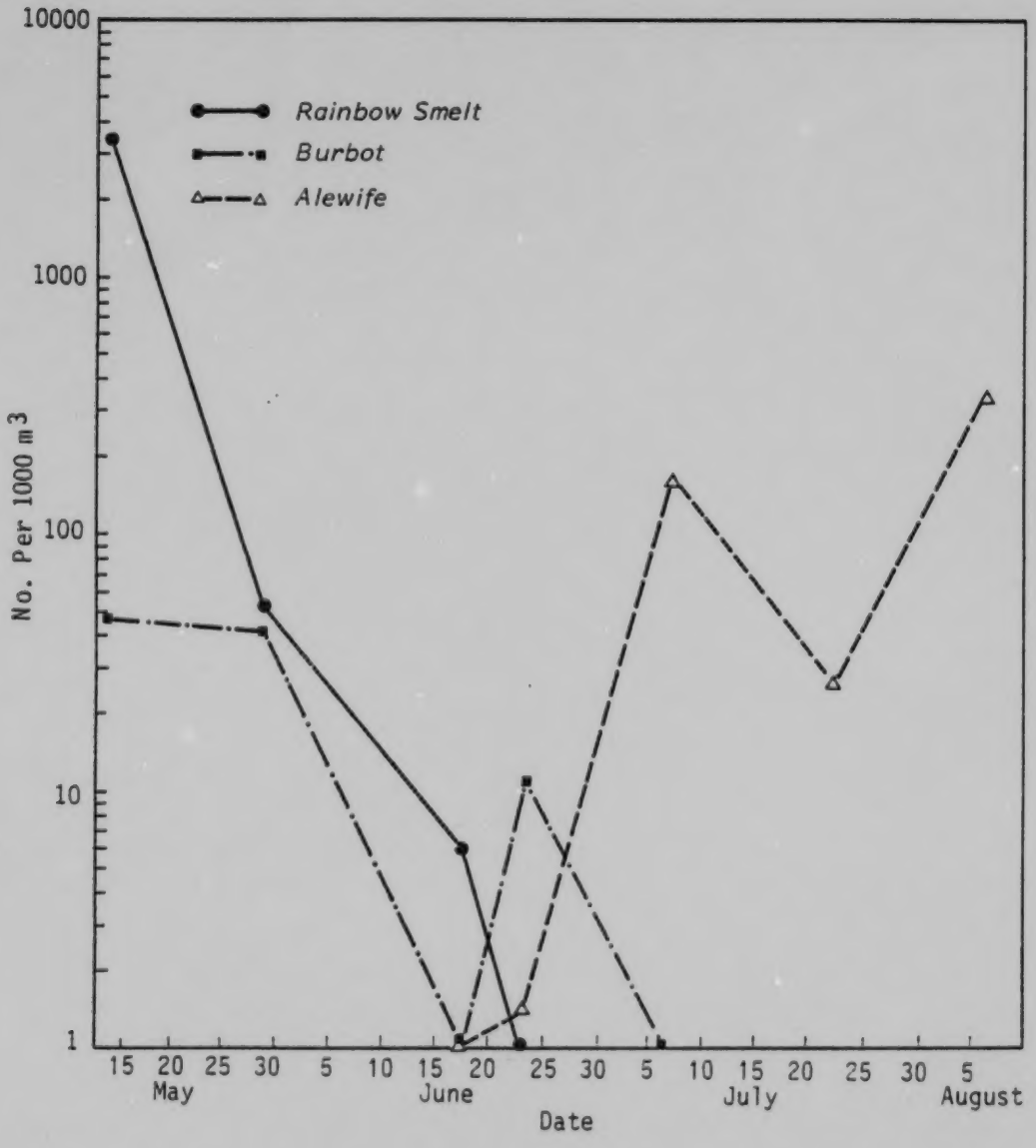


FIGURE 3.5-1

TEMPORAL CHANGES IN DENSITIES OF RAINBOW SMELT, ALEWIFE AND BURBOT LARVAE TAKEN IN SURFACE TOWS, BRUCE GSB, (MAY 14 INCLUDES MAY 14 AND MAY 20) 1981

161209 RD

TABLE 3.5-2

TOTAL LENGTHS OF LARVAL FISH - mm

Species	Date															
	May 14 $\bar{X}$	Range	May 20 $\bar{X}$	range	May 28 $\bar{X}$	Range	June 17 $\bar{X}$	range	June 23 $\bar{X}$	Range	July 7 $\bar{X}$	Range	July 23 $\bar{X}$	Range	August 6 $\bar{X}$	Range
Rainbow Smelt	6.3	4.5-7.5	6.1	5.5-7.0	6.3	5.5-7.0	9.4	6.0-18.0	14.0	10.0-20.0						
Alewife <7 mm									4.6	4.5-5.0	5.0	4.5-6.0	4.6	4.0-5.5	4.6	4.0-5.5
≥7 mm											12.8	7.0-18.0	18.5	8.5-25.0	17.8	9.0-23.0
Johnny Darter											6.1	5.0-7.5	6.1	5.5-8.0	6.7	5.0-8.0
Burbot	4.2	3.5-5.0			4.5	4.0-5.5			5.0	4.5-9.0						

Recently emerged alewife, mean length 4.6 - 5 mm, were found from June 23 to August 6. A distinct larger size group of alewife larvae was found on the last three sampling dates. Mean total lengths of these increased from 13 mm on July 7 to 18 mm on July 23 and August 6.

There was little change in the size of burbot or johnny darter larvae over the periods during which these species were captured. Catches of both species consisted almost entirely of recently emerged larvae.

Spatial Distribution

In assessing the spatial distributions of the major species, the total catches at each location were used as a measure of relative abundance (total sampling volume at each location was approximately 12,000 m^3). No attempt was made to provide absolute abundance (mean density) over the sampling period, since the inclusion of periods before larval emergence or after offshore dispersal would have made such values misleading.

The distribution of catches of the four most abundant larval fish species are shown in Table 3.5-3. Alongshore trends in surface catches were seen for rainbow smelt, which appeared to be more abundant in the southern half of the site, from South Boundary Road to Gunn Point, and for burbot, which were most numerous from the Bruce GS 'B' discharge transect to South Boundary Road. The only statistically significant difference among transects (two-way ANOVA: transect x depth contour, Appendix 7) was found for burbot. A multiple range test indicated that only the lowest and highest transect means (14 larvae/location at the Bruce GS 'B' intake transect and 4 at Holmes Bay) were statistically different.

Examination of the mean catches for depth contours (Table 3.5-3) suggested an onshore-offshore difference in abundance for smelt, alewife and johnny darter, but not burbot. Mean catches of rainbow smelt decreased with depth contour, from 480/location at 1 m to 170/location at 7 m. Analysis of variance and a multiple range test indicated a significant difference in smelt catches among depth contours, with the catches at 1 m significantly greater than those at 3 and 7 m. For alewife and johnny darter catches at the 7 m contour were somewhat lower than those at 1 and 3 m, but no statistically significant differences were found among depths. An unusually large catch of larval alewife on one date (August 6) at Gunn Point, 3 m (340 fish) accounted for the high catch at that location, and was partially responsible for the inability to detect significant spatial differences for alewife.

TABLE 3.5-3

SPATIAL DISTRIBUTION OF LARVAL FISH
(Total Catch at Each Location)

Species	Depth Contour	TRANSECT						
		Lagoon Bay	Bruce 'B' Discharge	Bruce 'B' Intake	South Boundary Rd	Holmes Bay	Gunn Point	Depth Mean
Rainbow Smelt	1 m	486	184	507	475	531	692	479
	3 m	32	288	64	592	83	373	239
	7 m	23	79	32	352	372	158	169
	Mean	180	184	201	473	329	407	295
		Bruce 'B' Intake Bottom 7 m: 18 12 m: 20						
Alewife	1 m	82	39	37	37	50	17	44
	3 m	34	45	35	24	34	346	86
	7 m	13	7	10	16	22	13	13.5
	Mean	43	30	27	26	35	125	48
		Bruce 'B' Intake Bottom 7m: 8 12m: 0						
Johnny Darter	1 m	17	20	21	15	4	5	14
	3 m	7	8	21	21	16	22	16
	7 m	5	2	3	23	7	19	10
	Mean	10	10	15	20	9	15	
		Bruce 'B' Intake Bottom 7 m: 2 12 m: 1						
Burbot	1 m	4	9	15	8	5	3	7
	3 m	15	14	19	10	2	7	11
	7 m	4	15	8	9	5	5	8
	Mean	8	13	14	9	4	5	9
		Bruce 'B' Intake Bottom 7 m: 7 12 m: 4						

The presence of substantial numbers of johnny darter larvae in 3 m and 7 m surface samples was unexpected, since they are normally demersal throughout their early life history (Balesic, MS, 1971). Turbulence and currents may have resulted in the suspension of these larvae in surface waters at the yolk sac stage when, with low density and poor swimming ability, they would have been susceptible to displacement.

Catches of larval fish in the bottom tows at 7 and 12 m, Bruce GS 'B' intake transect, were substantially lower than those in surface tows (Table 3.5-3). Smelt accounted for approximately two-thirds of the larvae taken in the bottom tows. When the density distributions of recently emerged smelt larvae (<8 mm) and more advanced larvae were compared (Table 3.5-4), it was found that the densities of newly emerged larvae were an order of magnitude higher in surface than bottom samples, whereas virtually all of the more advanced larvae were found in bottom samples. In contrast, there appeared to be no difference in the density distributions of newly hatched and advanced alewife larvae.

TABLE 3.5-4

DENSITY DISTRIBUTIONS OF SMALL AND LARGE ALEWIFE AND SMELT LARVAE RELATIVE TO DEPTH CONTOUR AND DEPTH (No/1000 m^3)

Species	Surface Samples			Bottom Samples
	1 m	3 m	7 m	7 + 12 m
Alewife <7 mm	47	87	12	2
Alewife ≥7 mm	22	50	10	1
Smelt <8 mm	787	391	277	17
Smelt ≥8 mm	0	0.2	0.2	14

3.5.2 Adult and Juvenile Fish
Monthly Netting Survey

Monthly surveys of fish populations, using gill nets, trap nets and beach seines, were carried out from Douglas Point to McRae Point (Figure 2.1-B). Gill nets were used to sample the near-shore fish populations at depths of 3 and 12 m, and were effective in the capture of adult and juvenile fish of approximately

12 cm or greater. Trap nets were used to sample fish of approximately 20 cm or greater length, moving along the shore in water of 1 -3 m depth. Beach seines sampled the shallow onshore environment, and were most effective in the capture of small species such as darters and various minnows, or the young-of-the-year of other species such as alewife and yellow perch. Fish taken by trap nets were returned alive to the lake.

Over 15,000 fish belonging to 47 species were taken in the combined survey (Table 3.5-5, Appendices 12-14). Approximately half of the fish caught were alewife. Longnose sucker, white sucker and spottail shiner were also taken in relatively large numbers. Twenty-six species which may be harvested in commercial or sport fisheries accounted for approximately 9% of the total catch. The most abundant of these were yellow perch, round whitefish and rainbow smelt.

The overall species composition resembled that observed in 1979. In that year alewife contributed 63% of the catch (8731 fish) while catches of suckers and spottail shiners were somewhat lower.

Gill Nets

Gill nets were fished monthly from May to November. All nets included mesh sizes 3.8 - 12.7 cm (1-1/2 inch to 5 inch). Since 2.5 cm mesh (1 inch) was not consistently included, and is quite different in selectivity from 3.8 cm mesh, it was treated as a separate gear type in analysis.

Over the year a total of 8282 fish belonging to 32 species was taken in gill nets (3.8 - 12.7 cm; Table 3.5-6). Alewife dominated the catch (48%) while longnose suckers and white suckers together contributed 30%. Alewife were dominant from May to August, but were insignificant later in the year, suggesting offshore migration. Previously, marked decline of inshore abundance of alewife had been observed in August (1979) or September (1980). White sucker dominated the catch in September and October. Although absent or insignificant from May to September, gizzard shad were dominant in November. Longnose sucker, although never numerically dominant, was the only species abundant throughout the year, contributing from 11 to 29% of the catch.

Several commercial or sport species were taken seasonally in moderate numbers. Round whitefish were taken in all months, but were most abundant from September to November. Yellow perch were taken in moderate numbers in June, September and October, but were rare in November. Walleye were only taken in the fall.

TABLE 3.5-5

FISH SPECIES COMPOSITION IN ALL GEAR TYPES -
BRUCE GS 'B' 1981 MONTHLY NETTING SURVEY

Species	Total	% Comp
Lake sturgeon	1	<0.1
Longnose gar	3	<0.1
Alewife	7 418	47.5
Gizzard shad	477	3.1
Pink salmon	1	<0.1
Cisco	6	<0.1
Coho salmon	2	<0.1
Chinook salmon	11	0.1
Round whitefish	323	2.1
Rainbow trout	6	<0.1
Brown trout	1	<0.1
Splake	4	<0.1
Rainbow smelt	271	1.7
Northern pike	2	<0.1
Redbelly dace	1	<0.1
Lake chub	536	3.4
Carp	8	<0.1
Golden shiner	3	<0.1
Emerald shiner	35	0.2
Common shiner	1	<0.1
Rosyface shiner	2	<0.1
Spottail shiner	1 622	10.4
Mimic shiner	7	<0.1
Bluntnose minnow	28	0.2
Longnose dace	127	0.8
Cyprinidae (unid.)	4	<0.1
Longnose sucker	2 302	13.2
White sucker	1 482	9.5
Golden redhorse	2	<0.1
Shorthead redhorse	36	0.2
Brown bullhead	1	<0.1
Channel catfish	59	0.4
Stone cat	2	<0.1
Burbot	129	0.8
Brook stickleback	1	<0.1
Threespine stickleback	5	<0.1
Trout-perch	3	<0.1
White bass	3	<0.1
Rock bass	11	0.1
Smallmouth bass	30	0.2
Fantail darter	3	<0.1
Johnny darter	7	<0.1
Yellow perch	548	3.5
Logperch	3	<0.1
Walleye	74	0.5
Freshwater drum	2	<0.1
Mottled sculpin	5	<0.1
Slimy sculpin	12	0.1
TOTAL	15 620	100.0

TABLE 3.5-6

TEMPORAL VARIABILITY OF FISH SPECIES COMPOSITION IN GILL NETS
(3.8 - 12.7 cm Mesh)

Species	Month															
	May		June		July		August		September		October		November		Year	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Lake sturgeon											1	<0.1			1	<0.1
Longnose gar									1	0.2	1	<0.1	1	0.1	3	<0.1
Alewife	1056	66.7	1185	60.9	1036	73.6	713	63.9	6	1.5	17	1.6	1	0.1	4013	48.9
Gizzard shad	1	<0.1	8	0.4					8	1.9	65	6.0	330	46.2	412	5.0
Pink salmon									1	0.2					1	<0.1
Cisco			1	<0.1	1	<0.1	2	0.2					2	0.3	6	<0.1
Coho Salmon					1	<0.1			1	0.7					2	<0.1
Chinook Salmon					6	0.4	1	<0.1	3	0.7	1	<0.1			11	0.1
Round whitefish	46	2.9	25	1.27	2	0.1	22	2.0	54	13.1	52	4.8	116	16.3	317	3.9
Rainbow trout									1	0.2	2	0.2	2	0.3	5	<0.1
Brown trout									1	0.2					1	<0.1
Splake	1	<0.1	1	<0.1									1	0.1	3	<0.1
Rainbow smelt	1	<0.1	6	0.3	12	0.9	3	0.3	1	0.2	16	1.5			39	0.5
Northern pike													2	0.3	2	<0.1
Lake chub	52	3.3	67	3.4	29	2.1	26	2.3	4	1.0	26	2.4	21	2.9	225	2.7
Carp	1	<0.1	1	<0.1					1	0.2	2	0.2	1	0.1	6	<0.1
Spottail shiner			1	<0.1							1	<0.1			2	<0.1
Longnose sucker	312	19.7	365	18.6	180	12.8	212	19.0	47	11.4	316	29.0	96	13.5	1528	18.6
White sucker	70	4.4	149	7.6	47	3.3	82	7.4	155	37.5	383	35.1	74	10.4	960	11.7
Golden redhorse											2	0.2			2	<0.1
Northern redhorse	1	<0.1	4	0.2			3	0.3	2	0.5	4	0.4			14	0.2
Brown bullhead			1	<0.1											1	<0.1
Channel catfish			25	1.3					3	0.7	27	2.5	1	0.1	56	0.7
Stone cat			1	<0.1					1	0.2					2	<0.1
Burbot	20	1.3	2	0.1	19	1.3	1	<0.1			26	2.4	55	7.7	123	1.5
White bass			1	<0.1							2	0.2			3	<0.1
Rock bass									3	0.7					3	<0.1
Smallmouth bass	1	<0.1							2	0.5	2	0.2			5	<0.1
Yellow perch	21	1.3	117	6.0	75	5.3	50	4.5	101	24.5	95	8.7	2	0.3	461	5.6
Log perch			1	<0.1											1	<0.1
Walleye									15	3.6	49	4.5	8	1.1	72	0.9
Freshwater drum									2	0.5					2	<0.1
TOTAL CATCH	1583		1961		1408		1115		413		1090		713		8282	
No of NETS	24		24		24		24		12		23		24			

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Eleven species totalling 634 fish were taken in 2.5 cm mesh gill nets (Table 3.5-7). Over the year lake chub and rainbow smelt were numerically dominant. Largest catches of these species were made in June (chub) and October (smelt). Although 2.5 cm mesh also effectively samples juvenile alewife and yellow perch, the numbers caught (71 and 16) were relatively small.

The distribution of gill net catch-per-unit effort by depth is shown for the more abundant species in Figure 3.5-2. In spring and summer catch-per-unit effort for the major species, including alewife, longnose sucker, white sucker and lake chub, was two times greater or more at 3 m than at 12 m. In fall, gizzard shad and round whitefish were caught in larger numbers at 3 m, but catches of both sucker species, yellow perch and creek chub were higher in deeper water. A portion of the higher catch of pelagic species (alewife and smelt in particular) at 3 m may have been due to a suspected higher capture efficiency of bottom-set gill nets in relatively shallow water.

The alongshore distribution of catch-per-unit-effort of major species in gill nets (3.8 - 12.5 cm only) is shown in Table 3.5-8. In spring alewife catches ranged from 25 fish/net (McRae Point) to 69 fish/net (Douglas Point). Relatively high catches (50 - 56 fish/net) were again obtained in summer, but only from the Bruce GS 'B' intake transect to Gunn Point. Longnose sucker were more numerous in the southern half of the study area in all seasons, with all catches over 15 fish/net made from Holmes Bay to McRae Point. The largest number caught over the year was on the southernmost transect, McRae Point (16 fish/set). White sucker were more evenly distributed, although relative large catches were obtained at Gunn Point and McRae Point in the fall (15 - 17 fish/set).

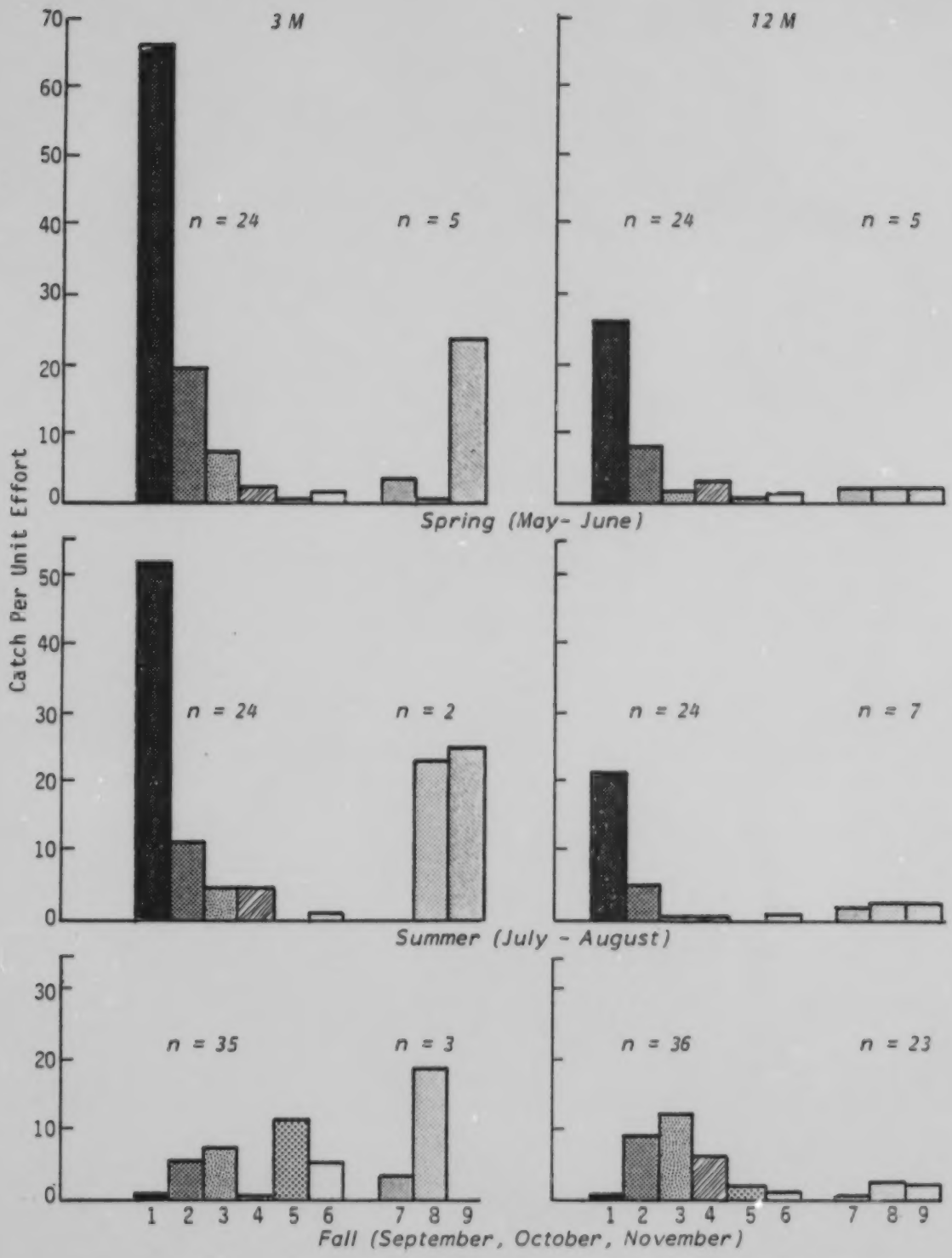
Of the less numerous species shown in Table 3.5-8, only gizzard shad appeared to be unevenly distributed, with relatively few caught on the two southern transects. The more valued species, round whitefish, yellow perch and walleye, were relatively evenly distributed along the study area.

Rainbow smelt and lake chub, which were only sampled effectively by 2.5 cm mesh gill nets, occurred on all transects. However, due to the uneven effort with this gear type, no further attempt was made to assess the alongshore distribution of either species.

TABLE 3.5-7

TEMPORAL VARIABILITY OF FISH SPECIES COMPOSITION IN 2.5 cm MESH GILL NETS

Species	May		June		July		August		September		October		November		Year	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Alewife	6	17.6	24	13.3	11	11.8	3	4.3			27	14.2			71	11.2
Round whitefish							1	1.4							1	0.2
Rainbow smelt	4	11.8	10	5.6	32	34.4	33	47.8	10	15.1	104	57.5	1	9.1	194	30.6
Spottail shiner	12	35.3	9	5.0			5	7.2	6	9.1	28	15.5			60	9.5
Lake chub	10	29.4	135	75.0	47	50.5	24	34.8	33	50.0	19	10.5	10	90.9	278	43.8
Longnose sucker			1	0.6	3	3.2	2	2.9	1	1.5					7	1.1
White sucker									1	1.5					1	0.2
Channel catfish									1	1.5	1	0.6			4	0.6
Trout perch	1	2.9	1	0.6					1	1.5	1	0.6			4	0.6
Yellow perch							1	1.5	13	19.7	2	1.1			16	2.5
Log perch	1	2.9													1	0.2
TOTAL CATCH	34		180		93		69		66		181		11		634	
No of NETS	2		8		6		4		6		11		8		45	



1 - Alewife
2 - Longnose Sucker
3 - White Sucker
4 - Yellow Perch
5 - Gizzard Shad
6 - Round Whitefish
7 - Juv. Alewife
8 - Rainbow Smelt
9 - Lake Chub

1-6: Catch in 3.8 - 12.7 cm Mesh Inclusive 7-9: Catch in 2.5 cm Mesh Only

FIGURE 3.5-2
DISTRIBUTION OF MAJOR FISH SPECIES IN
GILL NET CATCHES BY DEPTH AND SEASON

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TABLE 3.5-8

ALONGSHORE DISTRIBUTION OF MAJOR FISH SPECIES IN GILL NETS
(Catch-Per-Unit-Effort in 3.8 - 12.7 cm Mesh)

Species	Season	Location					
		Douglas Point	Bruce 'B' Discharge	Bruce 'B' Intake	Holmes Bay	Gunn Point	McRae Point
Alewife	Spring	69.1	42.0	49.1	46.4	48.5	25.0
	Summer	28.1	19.3	56.0	50.0	56.0	8.8
	Fall	0.1	0.2	0.1	1.5	0.2	0.3
	Year	31.1	18.9	32.4	30.4	32.2	10.5
Longnose Sucker	Spring	13.9	9.8	10.2	19.3	10.0	20.8
	Summer	4.9	4.3	6.5	6.2	16.2	10.6
	Fall	6.0	5.5	3.6	3.9	9.9	17.9
	Year	7.8	6.3	6.5	9.3	11.8	16.5
White Sucker	Spring	6.2	1.1	1.5	7.6	4.1	6.6
	Summer	0.8	2.5	2.6	6.6	2.2	1.3
	Fall	7.4	5.1	6.4	8.7	15.2	17.3
	Year	5.2	3.1	3.7	7.7	7.8	9.1
Yellow Perch	Spring	3.6	1.1	1.8	1.8	4.5	4.3
	Summer	0	1.0	2.5	7.8	1.5	2.4
	Fall	5.5	1.9	2.2	2.4	3.3	4.5
	Year	3.1	1.4	2.1	3.9	3.1	3.9
Gizzard Shad	Spring	0	0.1	0	0.6	0.3	0
	Summer	0	0	0	0	0	0
	Fall	7.9	7.5	12.1	7.6	3.7	2.0
	Year	2.8	2.9	4.7	3.1	1.5	0.8
Round Whitefish	Spring	2.7	1.1	0.9	1.3	1.8	1.0
	Summer	0.8	0.2	0.5	0.1	0.8	0.5
	Fall	3.5	2.8	4.2	3.7	4.7	3.2
	Year	2.5	1.5	2.0	1.8	2.6	1.6
Walleye	Fall	1.2	1.3	2.1	0.9	0.9	0.9

Trap Nets

The trap net catch consisted of 1603 fish of thirteen species (Table 3.5-9). Longnose and white suckers together contributed 80% of the catch over the year, accounting for from 65% (September) to 91% (October) of the catch in individual months. Longnose suckers were more abundant in four months, August and September being the exceptions. Notable numbers of adult lake chub and alewife were taken in trap nets in May only. Catches of yellow perch were modest and were spread over the spring and summer months. The centrarchids smallmouth bass and rock bass contributed only 32 individuals (2% of the catch) in all. The rock bass catch in particular was low in comparison to numbers taken in the Bruce GS 'A' study area to the north (eg, Ontario Hydro Research Division Report 82-182-K).

The alongshore distribution of suckers in trap net catches (Table 3.5-10) was similar to that obtained with gill nets, as the greatest numbers were taken in the southern portion of the sample grid. In spring and over the year longnose suckers were most abundant at McRae Point, while white sucker were most abundant at Gunn Point.

The majority of mature lake chub caught in trap nets in the spring were taken in Holmes Bay. It is possible that this is an area of spawning activity although other evidence is lacking.

Beach Seines

Beach seine catches totalled 5237 fish of twenty-six species. The majority of these (approximately 4400) were young-of-the-year alewife and spottail shiner taken in August (Table 3.5-11). Young-of-the-year alewife were also dominant in July, but in much lower numbers. Spottail shiner (adults and juveniles) were dominant in May and June, while gizzard shad were dominant in October. Very few young of salmonid or other game species were taken, and the catch of yellow perch young-of-the-year was relatively insignificant in comparison to beach seine catches at Bruce GS 'B' in 1980 (Ontario Hydro Research Division Report 82-205-K).

Alewife appeared to be much more abundant at McRae Point and Holmes Bay (142 and 68 fish/haul) than at the remaining beach seining sites (Table 3.5-12). Catches of juvenile gizzard shad were restricted almost entirely to the Douglas Point discharge in October. Spottail shiners and longnose dace were more evenly distributed, but tended to be most common in the central portion of the study area.

TABLE 3.5-9

TEMPORAL VARIABILITY OF FISH SPECIES COMPOSITION IN TRAP NETS

Species	Month													
	May		June		July		August		September		October		Year	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Alewife	48	6.1	5	2.1					2	2.6			55	3.4
Round whitefish	1	0.1					2	0.6	1	1.3	1	2.2	5	0.3
Splake									1	1.3			1	<0.1
Lake chub	131	16.6	1	0.4									132	8.2
Carp					1	1.0							1	<0.1
Longnose sucker	380	48.3	177	74.4	43	41.3	125	35.6	15	19.5	27	58.7	767	47.8
White sucker	218	27.7	36	15.1	38	36.5	180	51.3	34	44.2	15	32.6	521	32.5
Northern redhorse	2	0.3			2	1.9	7	2.0	8	10.4	3	6.5	22	1.4
Channel catfish			2	0.8									2	0.1
Burbot	1	0.1	3	1.3	2	1.9							6	0.4
Rock bass	2	0.3							6	7.8			8	0.5
Smallmouth bass	2	0.3			3	2.9	9	2.6	10	13.8			24	1.5
Yellow perch	2	0.3	14	5.9	15	14.4	28	8.0					59	3.7
TOTAL CATCH	787		238		104		351		77		46		1603	100
No OF NETS	20		20		10		20		18		12		100	

TABLE 3.5-10

ALONGSHORE DISTRIBUTION OF MAJOR FISH SPECIES IN TRAP NETS
(Catch-Per-Unit-Effort)

Species	Season	Location				
		Douglas Point	Bruce 'B' Discharge	Holmes Bay	Gunn Point	McRae Point
Longnose Sucker	Spring	0.6	6.8	18.8	17.4	35.6
	Summer	6.8	3.2	3.0	7.3	7.5
	Fall	0.5	1.0	0.1	3.0	1.5
	Year	3.1	4.5	4.6	9.4	15.5
White Sucker	Spring	0.6	6.0	7.9	10.8	6.5
	Summer	3.7	1.0	6.6	16.5	6.8
	Fall	0	0.3	0.1	3.6	2.0
	Year	1.7	3.4	4.9	9.7	5.0
Lake Chub	Spring	0	4.0	10.62	0.4	1.5

TABLE 3.5-11

TEMPORAL VARIABILITY OF FISH SPECIES COMPOSITION IN BEACH SEINES

Species	Month											
	May		June		July		August		October		Year	
	No	%	No	%	No	%	No	%	No	%	No	%
Alewife	20	5.7	2	1.7	74	63.2	3175	70.6	7	4.5	3278	62.6
Gizzard shad					2	1.7			63	40.4	65	1.2
Chinook Salmon			3	2.6							3	<0.1
Rainbow trout	1	0.3									1	<0.1
Rainbow smelt	32	9.1			4	3.4	1	0.0	1	0.6	38	0.7
Redbelly dace	1	0.3									1	<0.1
Lake Chub	24	6.8					9	0.2			33	0.6
Carp									1	0.6	1	<0.1
Golden shiner									3	1.9	3	<0.1
Emerald shiner	13	3.7	3	2.6					19	12.2	35	0.7
Common shiner			1	0.9							1	<0.1
Rosyface shiner							2	0.0			2	<0.1
Spottail shiner	197	55.8	70	60.9	27	23.1	1216	27.0	50	32.1	1560	29.8
Mimic shiner			1	0.9			6	0.1			7	0.1
Bluntnose minnow	1	0.3					27	0.6			28	0.5
Longnose dace	37	10.5	27	23.5			51	1.1	12	7.7	127	2.4
Cyprinidae*					4	3.4					4	<0.1
Brook stickleback	1	0.3									1	<0.1
Threespine stickleback	3	0.8			2	1.7					5	<0.1
Trout-perch	1	0.3	2	1.7							3	<0.1
Smallmouth bass			1	0.9							1	<0.1
Fantail darter	3	0.8									3	<0.1
Johnny darter	4	1.1	3	2.6							7	<0.1
Yellow perch					4	3.4	8	0.2			12	0.2
Log perch							1	0.0			1	<0.1
Mottled sculpin	4	1.1	1	0.9							5	<0.1
Slimy sculpin	11	3.1	1	0.9							12	0.2
TOTAL CATCH	353		115		117		4496		156		5237	
No OF SPECIES	16		12		6		10		8		26	
No OF SEINE HAULS	9		15		15		15		15		69	

*probably one of the above shiner species

TABLE 3.5-12

ALONGSHORE DISTRIBUTION OF MAJOR FISH SPECIES IN BEACH SEINES
(Catch-Per-Unit-Effort)

Species	Location					Mean CUE
	Douglas Point	Bruce 'B' Discharge	Holmes Bay	Gunn Point	McRae Point	
Alewife	0.9	4.5	68.5	3.4	142.3	43.9
Spottail shiner	9.3	39.7	33.7	19.5	10.0	22.4
Longnose dace	0	1.5	1.8	4.6	0.8	1.7
Gizzard Shad	5.3	0	0	0.1	0	1.1
All Species	17.5	46.8	112.0	30.4	155.2	72.4
No of Seine Hauls	12	12	15	15	15	

3.5.3 Acoustic Fish Census

Acoustic fish census was carried out to assess distribution and abundance of pelagic fish species at the site. Fish distribution was determined acoustically along thirteen transects extending from Douglas Point to Gunn Point. Four day samples and two night samples were obtained from June 2 to November 4.

Characteristics and Horizontal Distribution of Fish Echoes in Day Samples

The general characteristics and distribution of fish echoes were determined from analogue echograms. Fish echoes in day samples were characteristically observed as (i) individuals or clusters of several targets close to the bottom (demersal) and (ii) dense aggregations or schools of pelagic fish found either near bottom or in midwater (where fish were close to the bottom, the distinction between schools and demersal aggregations was arbitrary). The horizontal distribution of demersal aggregations and schools is shown in Figure 3.5-3. The relative contribution of demersal fish aggregations and pelagic fish schools ranged from almost completely demersal targets (July 7) to largely pelagic schools (September 3). Trends in horizontal distribution were apparent within samples, but were generally inconsistent from sample to sample.

Trends in Inshore-Offshore Distribution: In all samples fewer fish aggregations or schools were apparent in the inshore ends of the transects, within the 15 m contour. This was in large part due to the lower sampling volume at shallow depths. The lowest inshore abundance was apparent in November, followed by September and July. In June, inshore concentrations were primarily observed in the area of Holmes Bay and Gunn Point. The most restricted distribution appeared to occur in November, when the majority of fish were observed beyond the 25 m contour, and in September when the majority were found between the 15 and 25 m contours.

Inshore-offshore distributions (Figure 3.5-3) were compared with the temperature structure observed in inshore-offshore series of temperature profiles taken in conjunction with day samples on transect 7 (Figure 3.5-4). In the June, July and November samples, fish were distributed across isotherms intersecting the bottom, indicating that inshore-offshore distribution was not related to thermal gradients. However, in September the majority of fish schools appeared to be within, or at the lower margin of the thermocline, at temperatures ranging from 18° to 6°C. Occasional small schools were also found in upper midwater at temperatures of 19° to 20°C.

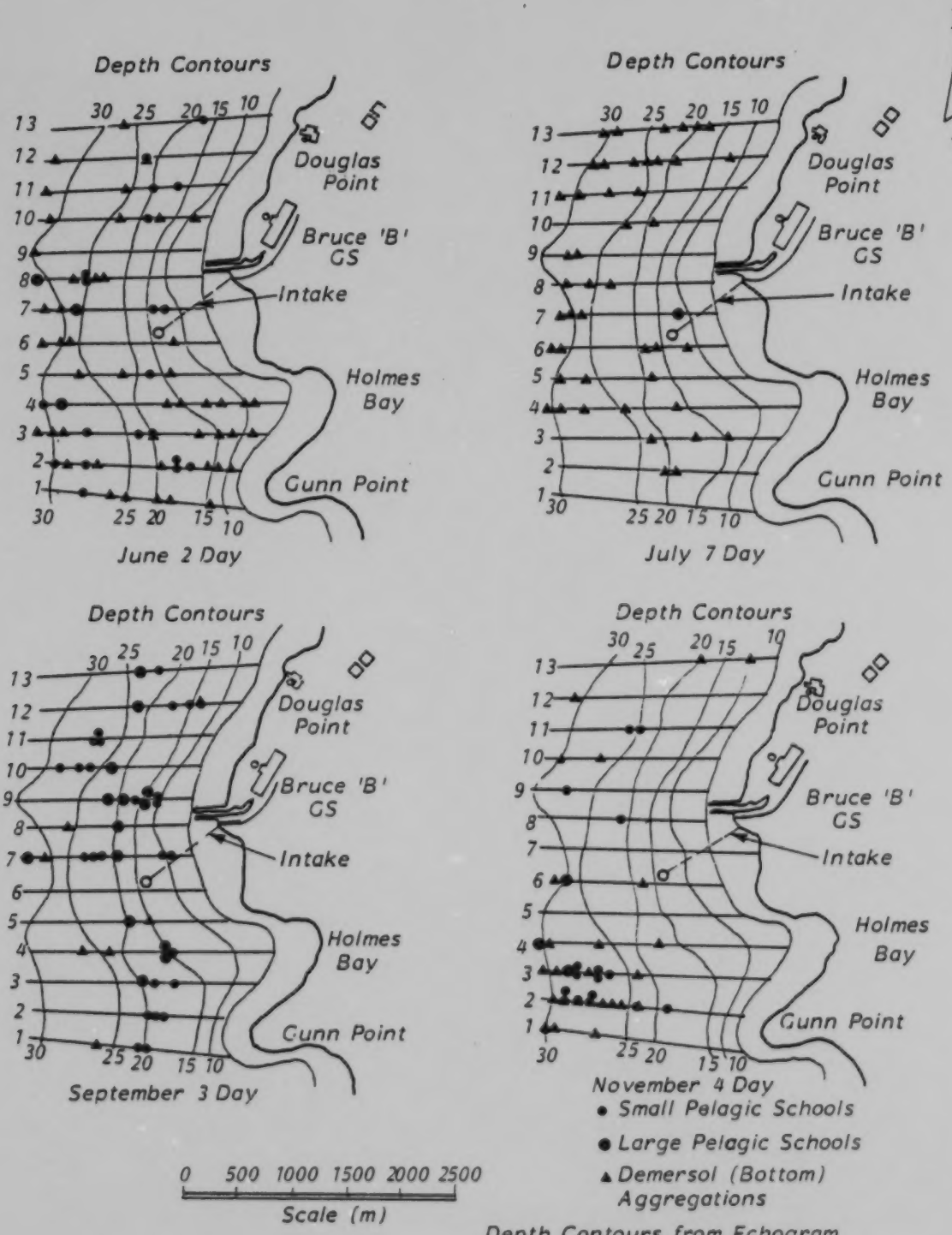

FIGURE 3.5-3

HORIZONTAL DISTRIBUTION OF ACOUSTICALLY OBSERVED FISH AGGREGATIONS

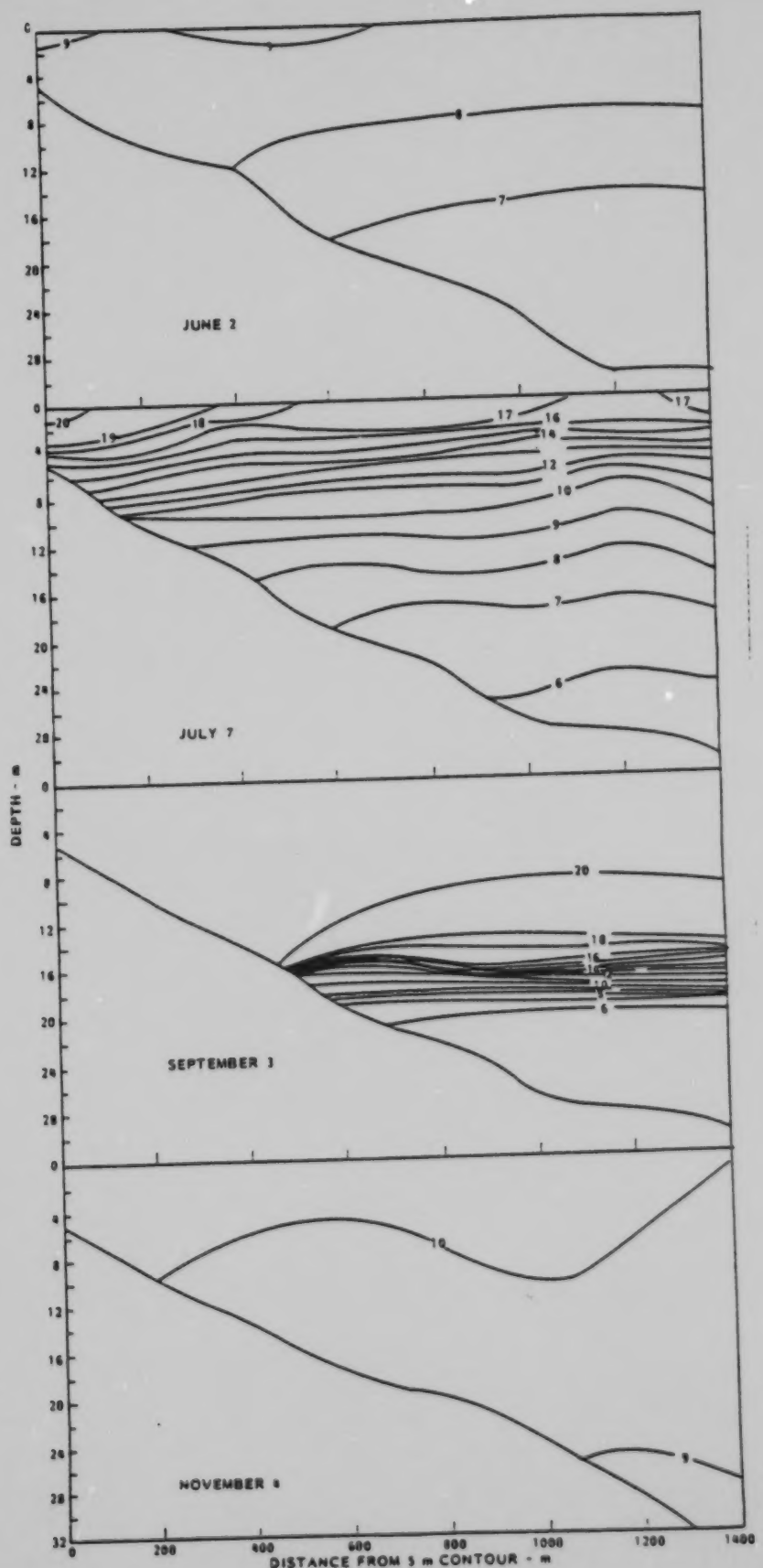

FIGURE 3.5-4

VERTICAL TEMPERATURE STRUCTURE DURING ACOUSTIC FISH CENSUS (TRANSECT 7)

20008 RD

Trends in Alongshore Distribution: More fish were observed in the southern half of the grid in June, September and November (Figure 3.5-3). In September the greatest concentration of schools was found off Bruce GS 'B' (Transect 9), although otherwise the alongshore distribution was relatively uniform. There were no obvious alongshore trends in July.

Characteristics and Horizontal Distribution of Fish Echoes in Night Samples

Fish were observed both in the water column and closely associated with the bottom at night. Those in the water column did not form schools (Figure 3.5-3 shows day samples only) and were generally well scattered. There was a greater tendency for the demersal targets to be aggregated. In addition, particularly in July, a large proportion of these were relatively strong targets (strong acoustic reflectors which give a high-amplitude echo on the axis of transmission).

In June considerably larger numbers of echoes, particularly those in the water column, were observed in the southern half of the grid. This was consistent with the distribution of pelagic schools and demersal aggregations in day samples. In July there were no apparent alongshore trends in distribution, but relatively more fish were observed in inshore waters than was the case in the corresponding day sample.

Fish Densities and Vertical Distribution

Fish densities were obtained for selected depths (11 - 15 m and 21 - 25 m) along Transects 6 and 7, which fall on either side of the Bruce GS 'B' intake location. Densities/hectare for these subsamples are given in Table 3.5-13, while vertical density distributions (no/10,000 m^3) are shown in Figure 3.5-5.

Densities at the intake depth ranged from 232/ha in the June 2 night sample to 1253/ha in the September 3 day sample. The November 4 sample had conspicuously lower densities at the intake depth than the remaining day samples.

In offshore waters densities ranged from 40/ha in the July 7 day sample to 383/ha in the September 3 sample.

With the exception of the July 7 and September 3 day samples, which included pelagic schools at 11 - 15 m depth contours, almost all fish at the intake depth tended to be on or near the bottom (Figure 3.5-5). In offshore waters densities were also generally higher within 6 m of bottom, but higher densities were observed in midwater in the September 3 (day) and June 2 (night) samples. In September this was attributed to pelagic schools

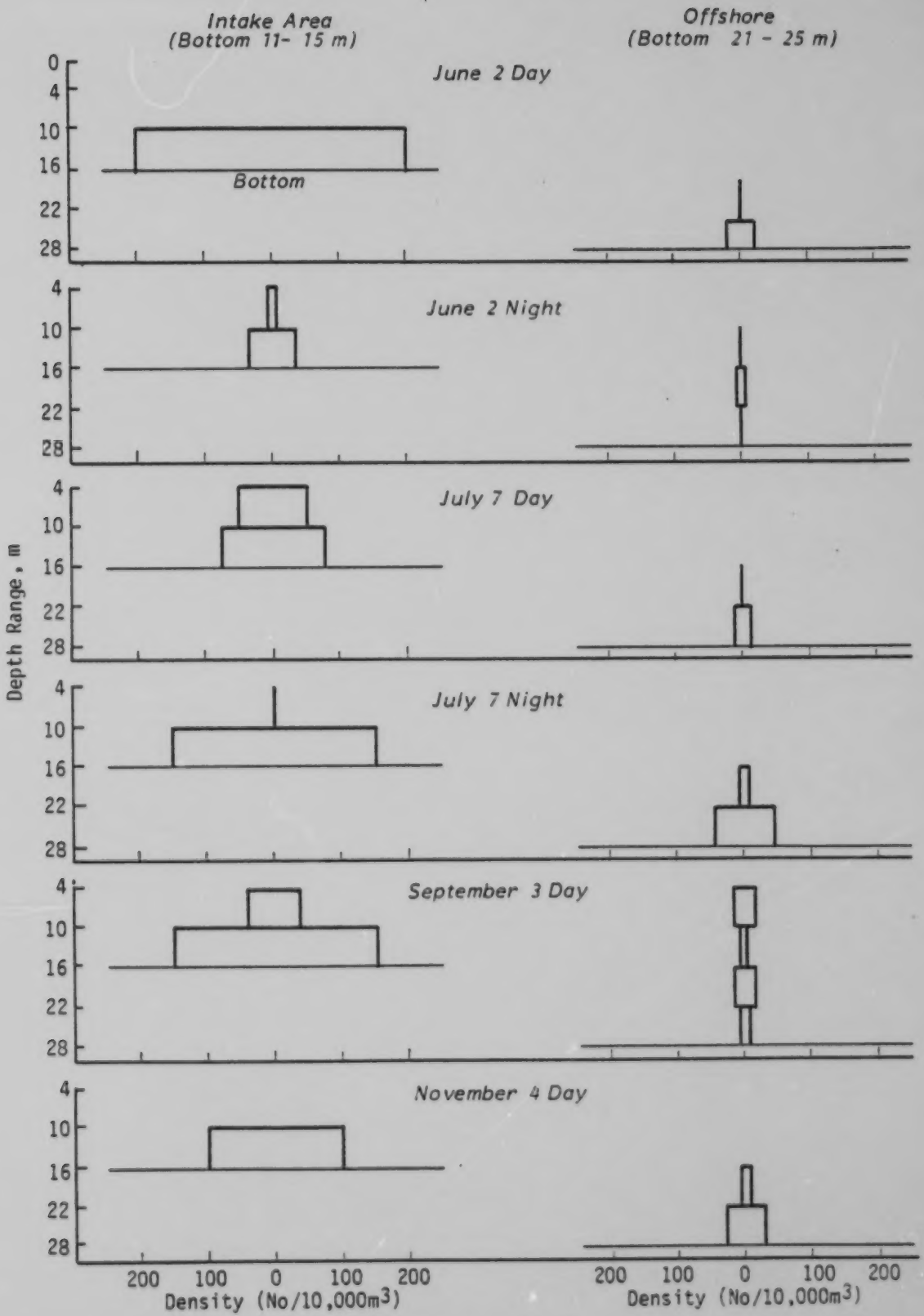

FIGURE 3.5-5

VERTICAL DENSITY DISTRIBUTIONS OF FISH ON SELECTED PORTIONS OF TRANSECTS 6 AND 7 OF THE ACOUSTICS GRID

161212 RD

which occurred in two depth ranges - 4-10 m and 16-22 m - which appeared to be largely separated by the thermocline (see Figure 3.5-4).

TABLE 3.5-13

ACOUSTICALLY OBSERVED FISH DENSITIES AT BRUCE GS 'B' IN 1981
(No of Fish/ha on Transects 6 and 7)

Sample		Mean No/ha	
		11 - 15 m Depth (Near Intake)	21 - 25 m Depth
Day:	June 2	1007	77
	July 7	1020	40
	Sept 3	1253	383
	Nov 4	451	120
Night:	June 2	232	85
	July 7	576	175

Species Composition of Acoustically Observed Targets

In 1981 attempts to identify fish species contributing to aggregations observed on the echograms by short-term gill netting were largely unsuccessful, yielding nine fish of five different species (Appendix 9). Species composition was therefore also inferred from overnight gill net data obtained in the routine (adult and juvenile fish) netting survey and from the characteristic echo aggregation patterns which have been shown to be indicative of alewife and rainbow smelt schools (Ontario Hydro Research Division Report No 80-197-K).

Alewife probably contributed the majority of fish echoes from June to September, based on May to August gill netting results and characteristic well resolved and vertically extensive pelagic schools observed in July and September. Rainbow smelt may have been important in offshore waters, particularly in September and November, as indicated by frequent small schools and clusters which were relatively dense and closely associated with the bottom. The strong demersal targets which were prevalent in July, and to a lesser extent June and November, were probably largely suckers. Gill netting results suggested that lake chub contributed substantially to fish echoes observed in June and July, and that some yellow perch, round whitefish and burbot were observed acoustically throughout the year.

3.5.4 Round Whitefish Spawning

To investigate the distribution and characteristics of round whitefish during their reproductive period in November and December, the normal monthly survey area was expanded to include three sites north of the Bruce GS 'B' study area: BHWP, MacPherson Bay and Scott Point. In addition to samples collected on November 24 and 25, which were carried on in conjunction with the monthly adult and juvenile fish survey, a set of samples was obtained on December 15.

Distribution and Abundance of Round Whitefish

The distribution of the round whitefish catch is given in Table 3.5-14. Complete data on all species caught in samples not included in the regular monthly survey is given in Appendix 15.

A total of 184 round whitefish was taken on the three dates. The catch-per-unit effort was much higher at 3 m than at 12 m, and was substantially higher on November 24/25 than on December 15. Netting on December 15 was conducted at lower ambient water temperatures (4-5°C versus 6-7°C on November 24/25) and under more turbulent conditions, both of which could have resulted in some movement of whitefish away from the nearshore area.

In November round whitefish were relatively evenly distributed from Scott Point to McRae Point. There was no evidence that at this time the fish were congregating around points of land, as was suggested by previous studies in Lake Ontario (Ontario Hydro Research Division Report 82-460-K). In December round whitefish continued to be caught at all transects, although more were caught in the northern half of the study area. The sample size and total number taken was too small to establish an alongshore trend in abundance.

During all three sampling dates surface water temperatures were elevated 1 - 4° above ambient on the four northernmost 3 m locations (Table 3.5-14). However, since buoyant plume conditions would still have prevailed, whitefish may not have been in water elevated in temperature when caught. On November 24 and 25 surface temperatures at 3 m at McRae Point were approximately 2° below ambient temperatures at other sites.

TABLE 3.5-14

DISTRIBUTION OF ROUND WHITEFISH IN NOVEMBER AND DECEMBER 1981
(Surface Water Temperature Shown in Parentheses)

Transect	Nov 24 & Nov 25		Dec 15		Transect Total
	3m	12 m	3 m	12 m	
Scott Point	10 (11,9)	2 (8,8)	2 (9)	0 (6)	14
MacPherson Bay	20 (8,8)	2 (7,7)	10 (8)	0 (5)	32
BHWP	8 (8,9)	0 (10,9)	5 (11)	0 (5)	13
Douglas Point	13 (8,9)	5 (8,7)	3 (7)	0 (6)	21
Bruce 'B' Disch	13 (7,7)	1 (7,7)	2 (4)	0 (4)	16
Bruce 'B' Intake	19 (7,7)	1 (6,7)	1 (4)	0 (5)	21
Holmes Bay	7 (7,9)	9 (7,7)	1 (5)	0 (5)	17
Gunn Point	20 (7,7)	3 (7,7)	1 (5)	1 (4)	25
McRae Point	20 (5,5)	3 (6,7)	2 (4)	-	25
Total Catch	130	26	27	1	184
Catch Per Unit Effort	7.2	1.4	3	0.1	

Biological Characteristics of Round Whitefish

The size, age and sexual characteristics of round whitefish taken in November and December were summarized by date and depth (Table 3.5-15). Size and age distribution were similar at 3 m and 12 m depths in November. The majority of individuals were aged 3 and 4 years, although significant numbers of age 5 - 8 were also collected. November fish averaged approximately 360 mm in length and 500 g in weight.

Mature females and ripe males were present in approximately equal proportions at both 3 and 12 m locations in November. A greater proportion of males at 12 m were not yet ripe. Post-spawn females (11) and males (2) totalled 11% of the catch at 3 m, but were absent from 12 m. The post-spawn females were older and larger fish than the males (age 6 - 9 versus 4 and 5). Post-spawn fish were taken on six of the nine transects in November, with the largest number (4) caught at McRae Point.

Round whitefish caught on December 15 were, on average, larger, older fish. All females and most males, totalling 93% of the fish caught, were in post-spawn condition.

3.5.5 Ecology of Major Fish Species

Eleven species of fish were considered of particular interest because of their abundance or value to man. Here an attempt is made to present as complete a picture as possible of the ecology of these species by integrating results of the four components of the fish study program and comparing these, where relevant, to published information.

Alewife

Alewife are considered a primary forage fish for salmon and trout (Argyle, 1982). This species was the most numerous taken in both ichthyoplankton and adult and juvenile fish surveys, and was presumed to contribute the bulk of fish observed to depths of 30 m in acoustic fish census.

By late summer alewife appeared to be largely restricted to depths beyond 15 m, and by November 4 they were concentrated in even deeper waters.

In spring large numbers of adult alewife were present close to shore, as indicated by high catches in 3 m gill nets, as well as moderate catches in trap nets and beach seines (some fish in the latter gear type were probably subadults). Results of acoustic census and gill nets set at 12 m suggested that alewife were also present in considerable numbers in waters beyond the 5 m contour.

TABLE 3.5-15

BIOLOGICAL CHARACTERISTICS OF ROUND WHITEFISH
CAUGHT IN NOVEMBER AND DECEMBER 1981

Characteristic		Date			
		Nov 24, 25		Dec 15	
		3 m	12 m	3 m	12 m
Total Examined		128	22	27	1
Fork Length - mm	$\bar{X}$	357	364	396	440
	Sd	39	35	36	-
Weight - g	$\bar{X}$	470	522	644	860
	Sd	189	195	203	-
% by Age: Age	2	1			
	3	29	23	7	
	4	38	46	18	
	5	9	4		
	6	6	9	52	
	7	5	14	22	
	8	8	4	22	
	9	2			
Age	$\bar{X}$	4.5	4.6	5.6	8
	Sd	1.2	1.5	1.2	-
% by Sex, Gonad Cond					
Females	Mature	27	23		
	Ripe	9	9		
	Post-Spawn	9		26	100
Males	Mature	19	41	3	
	Ripe	31	27	3	
	Post-Spawn	2		67	
Immature or Indistinguishable		5			

The high inshore abundance of adult alewife in spring was evidently related to spawning activity, as recently hatched prolarvae began to appear in early summer in ichthyoplankton tows. The distribution of adult alewife suggested spawning along the entire shoreline of the study area, and this was not contradicted by the distribution of larvae. As age 0 alewife developed they remained in the nearshore area, appearing in beach seines in large numbers in summer. Dispersal to offshore waters occurred before the September sampling, when inshore temperatures had fallen below 15°C.

Round Whitefish

As the most commonly caught salmonid species in the study area of Bruce GS 'B', round whitefish are of interest from the viewpoints of fisheries management and possible effects of station construction and operation.

Adult round whitefish utilize the nearshore waters of the entire study area throughout the year. They were present in spring, summer and fall in the current study, and were also present in moderate numbers during winter fishing (March 31 - April 2, 1981; Ontario Hydro Research Division Report No 82-205-K). The presence of this cold-water species in summer (albeit in low numbers) may have been due to the substantial inshore temperature decreases associated with upwellings. Similar intrusion of cold-water species including bloaters (a cisco) have been attributed to upwellings in Lake Michigan (Jude et al, 1979). However, largest numbers of whitefish were present in fall in both 1980 and 1981, and this appears to represent an inshore spawning migration.

The capture of largely post-spawn individuals in December, 1981, in shallow (3 m) water provides more substantial evidence of spawning near Ontario Hydro generating stations than has previously been obtained in lakes Huron (Ontario Hydro Research Division Report 82-205-K) or Ontario (Ontario Hydro Research Division Report 82-460-K). Ripe and post-spawn individuals were distributed throughout the study area, making it impossible to identify particular locations as spawning sites.

Catches of larvae, post-larval age 0 fish and juveniles (age 0+, 1, 2) were virtually non-existent, suggesting that round whitefish, if successfully hatching in the area, may disperse offshore as larvae in early spring and not return until mature, generally at age 3 or over. The inability to catch significant numbers of larvae in the spring probably reflected an inadequate bottom-sampling effort, inaccessibility resulting from their tendency to remain near the bottom (Ontario Hydro Research

Division Report 83-57-K) in areas dominated by boulders, rock ledges and other irregularities, and/or failure to sample spawning areas at the time the larvae first leave the substrate.

Walleye

Catches of this valuable game fish were similar to those in 1980. They were largely adults taken in gill nets in the fall throughout the sampling area. A large walleye caught off McRae Point in October bore a 'Natural Resources' tag attached during a spawning run in the Thames River, a tributary of Lake St Clair, on March 27, 1980. This tag return, and the transient presence of the walleye at the site indicated that they were widely ranging fish, although the number of stocks involved cannot be determined at present.

Previous studies at Bruce GS 'A' (Ontario Hydro Research Division Report 82-107-K) suggested the potential for concentration of walleye in heated discharges. Winter fishing in Bruce GS 'A' discharge in 1980-81 (Ontario Hydro Research Division Report 81-308-K) indicated that at least a small number of walleye remained in the discharge until mid-January. However, walleye had disappeared in February and March, when movement towards spawning grounds would be expected.

Rainbow Smelt

In Lake Huron this species is apparently second in abundance only to alewife (Argyle, 1982). Smelt are important not only as a forage fish for salmonids, but also potentially as a commercial species.

Although adult and juvenile rainbow smelt were not a major component of the catch in the monthly netting survey in the nearshore area, they appeared to constitute a major portion of the fish observed acoustically at depths from 15 - 30 m. In addition, larval smelt in the early stages of development were the most numerous ichthyoplankton present in larval tows in early spring. Low net catches of post-spawn adults and developing larvae (7.8 mm) can be attributed to rapid dispersal from inshore waters to deeper, colder offshore waters. This is in contrast with the prolonged inshore occurrence of both age 0 and adult alewife. In some circumstances, including the presence of (presumed) competitor species, smelt may shift their distribution to the epilimnion and upper hypolimnion (Crowder and Magnuson, 1982). However, smelt in the vicinity of BNPD-Bruce GS 'B' have been consistently found in the lower thermocline or hypolimnion once stratification became established (eg, Ontario Hydro Research Division Report 82-182-K).

Gizzard Shad

This clupeid species has in the past occurred at Bruce GS 'A' in large numbers and caused operational problems at Bruce GS 'A' due to mass movement into the intake forebay from the discharge through the recirculation duct (Ontario Hydro Research Division Report C78-31-K). Although gizzard shad dominated the November gill net catch, their numbers in December (whitefish spawning study) had decreased substantially. Inshore movement of gizzard shad in the fall may be associated with movement towards comparatively warm tributaries, including thermal discharges (Bodola, 1966). This may be due to cold intolerance, rather than preference for warm water. The fall temperature preferenda of gizzard shad (20°C) reported by Reutter and Herdendorf (1974) are not higher than those of a number of other great lakes species, but gizzard shad appear quite intolerant of low temperatures (Cox and Coutant, 1976) in comparison to other species such as smallmouth bass and salmonids (Hart, 1947). When most abundant in November, gizzard shad were distributed throughout the sampling area, but were least common at the southern end of the site which was coldest and furthest removed from the influence of thermal discharges. The decrease in numbers at the Bruce GS 'B' site in December may have been the result of movement into those discharges.

Gizzard shad larvae are reported to be pelagic but, unlike alewife or smelt, to leave the surface waters at nightfall (Stork et al, 1978). However, the total absence of shad larvae from the catch at either Bruce GS 'B' or Bruce GS 'A' sites (Ontario Hydro Research Division Report 82-107-K) suggests that spawning does not occur near the site. Similarly, although post-larval age 0 gizzard shad are known to move to shallow inshore waters, especially embayments and estuaries (Bodola, 1966), the lack of significant catches in beach seines suggested that the shoreline around the Bruce GS 'B' site is not utilized as a nursery area. This may be due to the lack of macrophyte growth and degree of exposure to wave action of the site.

Longnose Sucker

This species was second in numbers to alewife in gill net catches, and over the year dominated the trap net catches. Largest catches of longnose suckers were made in spring when they were moving actively along shore in relative shallow water (2 - 5 m). Longnose suckers continued to be present nearshore, but in reduced numbers, in summer. By fall the monthly gill netting effort was more productive in the offshore locations (nets extending from 12 - 18 m). However, acoustic observations

of demersal aggregations of relatively large fish suggested that a large proportion of longnose suckers may have moved to even deeper water (15 - 30 m) as early as July 7.

The temporal distribution of longnose suckers in 1981 differed somewhat from that in 1980, when peak gill net catches were made in late July at four of six locations. This species has a more northerly distribution than most other species found at the site (Scott and Crossman, 1973), and is generally considered to prefer relatively cool waters in summer, although specific published information on temperature preference is lacking. The observed year-to-year difference in summer catch is the reverse of what would have been expected on the basis of presumed temperature preference, since nearshore waters were approximately 6°C colder in July 1981 than in 1980 (14°C versus 20°C at the surface at 3 m depth).

The larger catches of suckers (both in trap nets and gill nets) on the two southernmost transects, McRae Point and Gunn Point, repeated a trend seen in 1980.

Sucker spawning occurs in both streams and lakes and commences at water temperatures just above 5°C (Scott and Crossman, 1973). It was likely that spawning had been substantially completed by the time of the May sampling. Very few sucker larvae were caught in larval tows and no young suckers were caught in beach seines. In the absence of published information, the early life history of longnose suckers at the Bruce GS 'B' site remains unknown.

White Sucker

White sucker occurred together with longnose sucker on most occasions and were next to longnose sucker in total catch. Comments made concerning the distribution and life history of longnose sucker are generally applicable to white sucker. The chief difference was that white sucker were relatively more prominent in nearshore waters in September and October when they dominated the gill and trap net catches.

Yellow Perch

Moderate catches of yellow perch were obtained in gill nets from June to October, and in trap nets from June to August. Low catches of yellow perch in May suggested that at that time the fish may still have been on or in the vicinity of their spawning grounds, a possibility consistent with the temperature regime in May (Scott and Crossman, 1973).

Catches of yellow perch in gill nets were lower than those obtained in 1980 (Ontario Hydro Research Division Report 82-205-K).

Catches of perch larvae were sparse in both 1980 and 1981, while age 0 perch were much less abundant in beach seines than in previous years. This difference may have been coincidental, since in previous years the majority of age 0 perch had been collected in a single set of samples. A second possibility is drastically reduced year class strength in 1981 due to effects of wind and temperature on survival of eggs and larvae up to 8 mm in length (Clady, 1976).

Burbot

Burbot, though considered coarse fish, are large piscivores, and as such may be competitors with more valued species, particularly salmonids.

Although they contributed less than 2% of the total gill net catch and were absent from trap nets and beach seines, burbot were the third most abundant species in ichthyoplankton tows. Burbot were caught throughout the year with the largest numbers taken in late fall. Early in the year burbot were probably present in the vicinity of the site but beyond the depths sampled by 12 m gill nets. Burbot were the third most abundant species taken at 35 m in the most recent Bruce GS 'B' Dumpsite investigation (preliminary data).

Spottail Shiner

Spottail shiner were second to alewife in abundance in the beach seine catch. In spring (May and June) adult and juvenile spottail shiner made up 50 to 60% of the total beach seine catch. At this time adults were probably spawning along the shoreline. In summer both adult and juveniles had apparently moved to deeper water and were being replaced by much larger numbers of age 0 fish. Spottail shiner remained close to shore during their early life history. They were found throughout the site but were most abundant from the Bruce GS 'B' discharge location to Holmes Bay. By October few spottail shiner were caught and these were concentrated at Douglas Point.

Scott and Crossman (1973) stressed the importance of spottail shiner as a forage species. Its consistently high abundance undoubtedly makes it a major component of the littoral food web in the Bruce GS 'B'-BNPD area.

Lake Chub

This species was the second most abundant cyprinid and was most prevalent in catches of 2.5 cm mesh gill nets. It was present throughout the nearshore area surrounding the site. The chub distribution appeared to shift somewhat from shallow to deeper waters between summer and fall. Moderate numbers of large chub were taken in trap nets in the spring, possibly during their spawning migration.

Early life history stages of lake chub were either not present or could not be identified from ichthyoplankton tows and beach seines.

4.0 SUMMARY

4.1 Physical and Chemical Characteristics

Substrate photography begun in 1980 was continued in 1981, with further locations to be sampled in 1982.

Sediment traps were set at 3, 7 and 12 m depths along nine transects, with material accumulated for approximately two month periods in spring, summer and fall. Although most tubes set in fall were lost due to storms, the range in sediment accumulation in those recovered (0.027 - 0.317 $g/cm^2/day$) was substantially higher than that found in summer (0.005 - 0.139 $g/cm^2/day$) or spring (<0.001 g - 0.101 $g/cm^2/day$). In spring sediment accumulation evidently decreased with depth but no other consistent spatial trends were found.

Continuous temperature monitoring near Bruce GS 'B' discharge location revealed a typically unstable inshore thermal regime, particularly in summer when inshore temperatures fluctuated from 8 to 23°C. Temperature profiles indicated that significant vertical gradients in temperature were infrequent and transient at depths to 12 m.

Oxygen content of the water was approximately at air saturation at all depths and locations.

Water transparency was measured on grids in July, August and October. It was highest in July (range 5.5 - 11.5 m Secchi depth), when it increased with distance from shore. Lowest transparency (3.5 - 4 m) was observed 1.5 - 2 km off the Douglas Point, Lagoon Bay and Bruce GS 'B' discharge locations in October, suggesting transport of materials from a shoreline area north of the Bruce GS 'B' site at that time. However, this was not related to construction activities.

Water chemistry was determined for surface and bottom samples taken on six dates from May 13 to November 10. Values for 23 chemical parameters were generally consistent with those obtained in Lake Huron in other surveys, and were within Ministry of Environment guidelines where criteria were available.

4.2 Attached Algae

Attached algae were sampled from shoreline and 3 m locations along the site in June, August and October. Seventeen taxa of attached algae were identified in the samples. In shoreline samples *Ulothrix* was dominant in June throughout the site, while in August and October dominant species varied from site to site. *Zygnema* was more prominent at the 3 m sampling locations. Species composition and seasonal distribution differed substantially between 1979 and 1981. Problems of identity of some taxa with similar morphologies may have contributed to the apparent differences.

Analysis of spatial and temporal trends in algal biomass did not reveal ecologically meaningful trends.

4.3 Zoobenthos

The benthic fauna was sampled by vacuum dome during spring and fall. Oligochaetes (55%) and dipteran larvae (41%) contributed most of the organisms collected. The most numerous individual taxa were, in order, *Nais simplex*, *Nais pardalis*, (oligochaetes) and *Pseudosmittia* (dipteran:chironomid).

Zoobenthic diversity, as measured by the number of taxa and Shannon-Weiner diversity index, was greatest at Holmes Bay, which is somewhat protected and has a finer and more heterogeneous substrate than other locations. Diversity was generally lowest at the 12 m locations.

Samples at 1 and 3 m were generally dominated by *Nais* species, while samples at 7 and 12 m tended to be dominated by chironomids. Chironomids were more prevalent at the shallow locations in the fall than in the spring. No consistent relationship was evident between zoobenthic species composition and substrate or attached algae.

Overall density of zoobenthic organisms in 1981 was approximately 1200/m^2. Densities were substantially higher in spring than fall (1700 versus 700 organisms/m^2). That this was the reverse of the seasonal change seen in 1979 may have been due to the timing of large-scale nearshore disturbance (storms), or to other unknown factors.

In spring mean densities at 1 m (5000 organisms/m^2) were an order of magnitude higher than at the remaining depths. However, in fall fewer organisms were found at 1 m than at intermediate depths, probable as a result of increased wave action and reduced water levels. Although highest zoobenthic densities were found on the Holmes Bay transect trends in density alongshore were considerably less pronounced than those with depth.

4.4 Fish

Ichthyoplankton was sampled with tow nets between May 14 and August 6. In all, over 5000 larval fish were captured, the majority of which were rainbow smelt (76%) and alewife (12%). Only two coregonid larvae (one round whitefish and one cisco) were captured.

Adult and juvenile fish were sampled monthly from May to November using gill nets, trap nets and beach seines. The fish catch in standard experimental gill nets (3.8 - 12.7 cm mesh) was dominated by alewife, longnose sucker and white sucker. Small-mesh (2.4 cm) experimental gill nets captured predominantly lake chub and rainbow smelt. Longnose and white suckers dominated the trap net catch, while young-of-the-year alewife and spottail shiner made up the bulk of the beach seine catches.

Acoustic observations of fish distribution included four day and two night samples from June to November. By day fish were characteristically observed as demersal aggregations and pelagic schools. Their relative contribution ranged from almost completely demersal targets (July 7) to largely pelagic schools (September 3). By night fish were found both scattered through the water column and aggregated along the bottom. Although there were spatial trends within samples, these were generally not consistent from sample to sample. The most obvious trends were the presence of larger numbers of fish in the southern half of the grid on June 2 (day and night), very low numbers of fish in inshore waters on November 4, and concentration of fish in and just below the thermocline on September 3.

Acoustically estimated fish densities in grid subsamples in the vicinity of the Bruce GS 'B' intake ranged from 232 fish/hectare in the June 2 night sample to 1253 fish/hectare in the September 3 day sample.

Acoustic targets observed from June to September appeared to have been largely alewife. Rainbow smelt appeared to contribute a large proportion of the targets in offshore waters, particularly in September and November. Large fish observed throughout the site, particularly in July, were probably largely suckers.

An expanded gill netting survey was carried out in November and December to investigate the distribution and characteristics of round whitefish during their spawning season. A total of 184 round whitefish were taken, almost all of which were adults. The largest number of fish was taken at the 3 m depth on November 24-25. The whitefish were found in moderate numbers along the entire shoreline from MacPherson Bay to McRae Point. Spawning in or near the study area was suggested by the reproductive condition of the fish, which was predominately ripe and post-spawn. Post-spawn fish made up 10% of the whitefish caught in November, and 93% of those caught in December.

Results of ichthyoplankton sampling, monthly netting and acoustic survey were integrated to describe the ecology of individual major species. Adult alewife were present in large numbers near shore during their reproductive period in spring and early summer with spawning apparently occurring along the entire shoreline of the site. Larval alewife remained near shore as they developed. Movement of both age 0 fish and adults into deeper waters took place at some time before late September.

Adult round whitefish utilized the nearshore area along the Bruce GS 'B' site throughout the year, but were most abundant during late fall before and during the spawning period. Larval and juvenile round whitefish apparently did not utilize the nearshore waters of the study area.

By the time sampling began in May adult rainbow smelt had already completed their spawning migration and moved offshore. Larval smelt, which were present in high densities in nearshore surface waters in May, rapidly moved to deeper waters as they developed. Smelt appeared to be present in large numbers in waters beyond 15 m, particularly in the fall.

Gizzard shad were present inshore in substantial numbers only in November, when they dominated the gill net catch. They were present throughout the site, but were more abundant at the northern locations. Longnose and white suckers were present in shallow water (1 - 3 m) in large numbers in spring but were apparently more abundant in deeper water (12 - 30 m) in summer and fall. Although common along the entire study area, they were most abundant at the southern locations from Holmes Bay to McRae Point.

Spottail shiner probably spawned along the Bruce GS 'B' shoreline, with the larvae, but not the adults, remaining close to shore until late summer. They were most abundant from the Bruce GS 'B' discharge location to Holmes Bay.

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APPENDIX 1

SUBSTRATE PERCENT COMPOSITION

1 m Locations

Location	Replicate	Bedrock	Boulder	Cobble	Pebble	Gravel	Sand
McRae Point	A	59		5	36		
	B	100					
	C		56	36	8		
	$\bar{X}$	53	19	14	14		
McRae Point	A		30	34	30	6	
to	B	24		27	37	12	
Inverhuron Bay	C	100					
	$\bar{X}$	41	10	20	22	6	
Inverhuron Bay	A	100					
	B	100					
	C	96			4		
	$\bar{X}$	99			1		
Inverhuron Bay	A						100
to	B						100
Gunn Point	C						100
	$\bar{X}$						100
Gunn Point	A	100					
	B	100					
	C	100					
	$\bar{X}$	100					

APPENDIX 1 (Cont'd)

SUBSTRATE PERCENT COMPOSITION

1 m Locations

Location	Replicate	Bedrock	Boulder	Cobble	Pebble	Gravel	Sand
Gunn Point to Holmes Bay	A	100					
	B	87		12	1		
	C	100					
	X	96		4			
Holmes Bay	A		31	69			
	B		25	43	29	3	
	C			75	24	1	
	X		19	62	18	1	
Holmes Bay to South Boundary Point	A			77	20	3	
	B		70	16	12	2	
	C		43	13	39	5	
	X		38	35	24	3	
South Boundary Point	A	59		14	27		
	B	100					
	C	91		9			
	X	83		8	9		
South Boundary Point to Intake	A	80		19	1		
	B	100					
	C			91	9		
	X	60		37	3		

APPENDIX 1 (Cont'd)

SUBSTRATE PERCENT COMPOSITION

Location	Depth	Replicate	Bedrock	Boulder	Cobble	Pebble	Gravel	Sand
Bruce 'B' Discharge	5 m	A	100					
		B		96	4			
		C		76	24			
		$\bar{X}$	33	58	9			
Bruce 'B' Discharge to Lagoon Bay	7 m	A	100					
		B		36	60	4		
		C	100					
		$\bar{X}$	67	12	20	1		

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APPENDIX 2A

INORGANIC SEDIMENTATION
($g/cm^2/day$)

Depth (m)	Douglas Point	Lagoon Bay	Bruce 'B' Discharge	Bruce 'B' Intake	South Boundary Road	Holmes Bay	Gunn Point	Inverhuron Bay	McRae Point	Depth Means
MAY - JULY										
3	0.0045	0.0043	0.0315	0.0038	0.0069	0.0037	0.0032	0.0028	0.1000	0.0179
7	0.0044	0.0051	0.0017	0.0039	0.0043	0.0048	0.0028	0.0047	0.0045	0.0040
12	0.0079*	0.0024	0.0027	0.0025	0.0017	-	0.0004	0.0016	0.0006	0.0017
Transect Means	0.0045	0.0039	0.0120	0.0034	0.0043	0.0043	0.0021	0.0030	0.0350	
JULY - SEPTEMBER										
3	0.0118	0.0217	0.0468	0.0066	0.0077	0.0578	0.0102	0.0567	0.0291	0.0276
7	0.0125	-	0.0194	0.0242	-	0.0432	0.0156	0.1341	0.0213	0.0386
12	-	0.0188	-	0.0717	0.0131	-	0.0047	0.0084	0.0193	0.0227
Transect Means	0.0122	0.0203	0.0031	0.0342	0.0104	0.0505	0.0102	0.0664	0.0232	
OCTOBER - NOVEMBER										
3	-	-	-	-	-	0.0264	-	-	0.1308	0.0786
7	-	-	-	-	-	-	-	-	0.3130	0.3130
12	-	-	0.0717	0.2948	-	-	-	-	0.0338	0.1334
Transect Means	-	-	0.0717	0.2948	-	0.0264	-	-	0.1592	

* tubes straightened during sampling period, not included in means.

APPENDIX 2B

LOSS-ON-IGNITION SEDIMENTATION
($g/cm^2/day$)

Depth (m)	Douglas Point	Lagoon Bay	Bruce 'B' Discharge	Bruce 'B' Intake	South Boundary Road	Holmes Bay	Gunn Point	Inverhuron Bay	McRae Point	Depth Means
MAY - JULY										
3	1.0005	0.0005	0.0038	0.0004	0.0006	0.0003	0.0003	0.0003	0.0012	0.0009
7	0.0004	0.0004	0.0002	0.0003	0.0003	0.0006	0.0003	0.0003	0.0005	0.0004
12	0.0005*	0.0001	0.0001	0.0001	0.0001	-	0.0001	0.0001	0.0001	0.0001
Transect Means	0.0005	0.0003	0.0014	0.0003	0.0005	0.0005	0.0002	0.0002	0.0006	
JULY - SEPTEMBER										
3	0.0010	0.0021	0.0036	0.0004	0.0005	0.0040	0.0006	0.0014	0.0016	0.0017
7	0.0010	-	0.0014	0.0012	-	0.0026	0.0009	0.0058	0.0012	0.0029
12	-	0.0013	-	0.0015	0.0008	-	0.0004	0.0004	0.0013	0.0010
Transect Means	0.0010	0.0017	0.0025	0.0010	0.0007	0.0033	0.0006	0.0025	0.0014	
OCTOBER - NOVEMBER										
3	-	-	-	-	-	0.0010	-	-	0.0020	0.0015
7	-	-	-	-	-	-	-	-	0.0038	0.0038
12	-	-	0.0009	0.0043	-	-	-	-	0.0005	0.0019
Transect Means	-	-	0.0009	0.0043	-	0.0010	-	-	0.0021	

APPENDIX 3

DAILY TEMPERATURES 1 km OFF BRUCE GS 'B' DISCHARGE
2.5 m DEPTH

Day	Month								
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1		4.4	7.1		15.3	20.1	15.2	9.4	7.3
2		5.0	5.4		17.7	20.5	14.3	9.3	6.5
3		5.4	5.7		18.7	20.4	12.9	9.3	6.3
4		4.8	6.8		18.9	20.1	11.3	9.3	7.2
5		4.8	8.8		19.4	19.8	12.5	9.4	
6		5.2	8.7		18.4	18.4	13.8	9.3	
7		5.9	8.9		18.1	18.0	13.2	9.1	
8		4.0	8.7	19.0	18.7	19.8	12.2	8.9	
9		4.5	7.7	18.9	19.6	19.1	9.5	8.6	
10		4.2	8.9	18.8	20.1	17.5	9.4	8.4	
11		6.2	9.7	18.9	20.4	16.5	10.7	7.9	
12		6.5	10.5	18.3	20.0	18.1	10.8	8.1	
13		6.6	10.5	19.3	19.9	18.7	11.5	8.3	
14		6.1	10.8	14.9		18.9	11.6	8.1	
15		5.0	11.8	12.7		19.0	11.9	8.2	
16		5.8	14.0	14.5		18.3	12.1	8.2	
17		5.5	14.7	15.7		15.2	11.7	8.5	
18		6.7	14.9	17.4	10.1	10.5	11.5	7.8	
19		7.1	14.6	17.9	10.7	16.4	11.2	7.8	
20		7.7	13.9	18.6	13.2	17.0	10.9	7.4	
21		7.7		13.4	15.2	17.0	10.9	7.0	
22	7.2	8.5		9.9	16.4	16.6	10.3	7.5	
23	5.8	8.4		12.5	20.0	15.8	9.7	7.1	
24	3.9	9.4		13.3	19.0	15.6	9.5	7.0	
25	3.8	9.8		14.1	19.4	15.9	9.4	7.2	
26	2.7	10.1		15.4	18.7	16.3	9.4	7.1	
27	3.0	8.2		15.1	19.7	16.3	9.2	6.9	
28	3.4	7.4		10.6	19.1	16.0	9.2	6.1	
29	3.8	9.1		7.2	19.0	15.8	9.3	7.3	
30	3.5	9.9		7.8	19.3	15.6	9.1	7.5	
31		7.3		12.5	19.8		8.9		
MN	4.1	5.7	10.1	14.9	18.0	17.4	11.1	8.1	
MIN	2.7	4.0	5.4	7.2	10.1	10.5	8.9	6.1	
MAX	7.2	10.1	14.9	19.3	20.4	20.5	15.2	9.4	

APPENDIX 4

TEMPERATURE AND OXYGEN PROFILES
BRUCE GS 'B', 1981

Depth	July 9				July 29				August 20				October 5				October 30				December 7			
	Intake		Gunn Pt.		Intake		Gunn Pt.		Intake		Gunn Pt.		Intake		Gunn Pt.		Intake		Gunn Pt.		Intake		Gunn Pt.	
	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2	Temp	O_2
Surface	20.2	9.9	20.5	9.6	9.5	11.3	11.2	11.3	15.1	10.5	15.4	10.4	13.3	10.2	13.5	10.0	9.6	11.3	9.4	11.1	6.4	11.4	6.4	11.4
1	20.0	9.8	20.2	9.6	7.6	11.5	8.5	11.5	15.0	10.5	15.2	10.4	13.2	10.1	13.4	10.0	9.5	11.2	9.3	11.1	6.4	11.3	6.4	11.4
2	20.0	9.8	20.2	9.6	6.9	11.6	7.2	11.6	14.8	10.5	14.9	10.5	13.2	10.1	13.2	10.0	9.5	11.1	9.3	11.1	6.4	11.4	6.5	11.4
3	19.9	9.8	20.0	9.6	6.8	11.6	6.7	11.7	13.9	10.8	14.1	10.7	13.2	10.1	13.1	10.0	9.5	11.1	9.3	11.1	6.4	11.4	6.5	11.4
4	19.9	9.8	20.0	9.6	6.7	11.6	6.6	11.7	13.7	10.8	13.9	10.7	13.1	10.0	13.1	10.0	9.5	11.0	9.2	11.0	6.4	11.4	6.5	11.4
5	19.9	9.9	20.0	9.7	6.4	11.6	6.4	11.7	13.6	10.8	13.8	10.7	13.0	10.0	13.1	10.0	9.4	11.0	9.2	11.0	6.5	11.5	6.5	11.4
6	19.5	9.9	20.0	9.7	6.1	11.7	6.3	11.7	13.4	10.9	13.6	10.8	12.9	10.0	13.0	10.0	9.3	11.0	9.2	11.0	6.4	11.4	6.5	11.4
7	19.5	9.9	20.0	9.7	5.9	11.7	6.2	11.7	13.2	10.9	12.2	11.1	12.9	10.0	12.9	10.0	9.2	11.0	9.2	11.0	6.4	11.4	6.5	11.4
8	19.5	9.9	20.0	9.7	5.8	11.7	6.1	11.8	12.9	11.0	10.6	11.4	12.9	10.0	12.8	10.1	9.2	11.0	9.1	11.0	6.4	11.4	6.5	11.4
9	19.5	10.0	20.0	9.8	5.8	11.7	6.0	11.8	11.2	11.3	9.4	11.6	12.9	10.1	12.7	10.1	9.2	11.0	9.1	10.9	6.4	11.4	6.5	11.4
10	19.5	10.0	20.0	9.8	5.7	11.7	5.6	12.0	10.4	11.6	8.4	11.8	12.8	10.1	12.6	10.1	9.2	11.0	9.1	10.9	6.5	11.4	6.5	11.5
11	19.0	10.0	20.0	9.8	5.7	11.8	5.6	12.0	10.3	11.6	8.4	11.9	12.8	10.1	12.5	10.2	9.2	11.0	9.0	10.8	6.5	11.5	6.5	11.5
12	19.0	10.0	20.0	9.8	5.8	11.9	5.7	12.0	9.0	12.1	8.4	11.9	12.8	10.1	12.5	10.2	9.2	10.9	9.0	10.3	6.5	11.5	6.5	11.5

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APPENDIX 5

ASH-FREE DRY WEIGHT OF ATTACHED ALGAE - g/m²

Transect	Shoreline			3 m		
	JUNE	AUGUST	OCTOBER	JUNE	AUGUST	OCTOBER
Douglas Point	14.3	29.0	2.0	5.3	20.3	5.9
	44.0	16.0	2.1	4.7	24.4	3.7
	17.2	29.1	2.2	4.6	29.1	5.9
Lagoon Bay	54.0	3.3	8.6	8.1	5.7	2.7*
	63.9	8.3	17.5	6.1	10.2	2.6*
	5.2	3.8	6.4	9.4	7.8	1.8*
Bruce 'B' Discharge	14.7	2.6	3.2	33.6	15.5	8.7*
	15.6	5.2	5.1	41.8	21.4	55.5*
	13.6	6.7	2.6	47.0*	27.9	53.5*
Bruce 'B' Intake	18.9*	5.4	6.2	13.5*	9.4	7.2
	16.5*	4.0	23.8	9.6*	11.7	4.2
	20.6*	8.2	23.9	8.8	16.0	2.0
South Boundary	11.3	6.1	5.3	21.7*	19.3	9.7
	10.8*	2.4	1.6	18.2*	14.9	11.6
	11.3*	1.9	16.9	4.5*	14.7	1.4
Holmes Bay	18.4*	2.8	3.8	8.9	6.4	1.5*
	35.8*	4.1	6.4	8.1	12.0	11.2*
	24.0*	6.4	1.6	9.4	15.6	1.4*
Gunn Point	14.5*	6.2	26.9*	10.7*	2.2	22.3*
	38.2*	7.5	22.0*	3.1	3.8	23.4*
	17.2	2.8	19.9*	5.5	7.0	17.3*

*Sample was all or mainly detritus.

APPENDIX 5a

WATER TEMPERATURES AT BRUCE GS "B" RECORDED ON THE COLLECTION DATES FOR ATTACHED ALGAE

LOCATION	DEPTH	Date JUNE 4	AUGUST 4
Bruce "B" Intake	S	NR	21.0°C
	3M	8.8°C	21.0°C
Bruce "B" Discharge	S	NR	20.0°C
	3M	9.3°C	20.0°C
Lagoon Bay	S	NR	20.0°C
	3M	9.5°C	20.0°C
Douglas Point	S	14.0°C	24.5°C
	3M	9.0°C	NR
Gunn Point	S	14.0°C	21.0°C
	3M	NR	NR
Holmes Bay	S	NR	NR
	3M	NR	20.0°C
South Boundary	S	NR	21.0°C
	3M	9.0°C	21.0°C

NR - Not recorded

NOTE: Water temperatures were not recorded in October.

APPENDIX 6

ANALYSIS OF SPATIAL VARIATION IN BENTHIC DENSITIES

2-Way ANOVA; Data ℓn-transformed to reduce heterogeneity of variance.

JUNE-JULY ANOVA

Source of Variation	SS	Deg F	MS	F	Sign. Level
Among Transects	13.09	6	2.18	0.67	Not Sign.
Among Depths	47.53	3	15.84	4.67	Sign. at 5%
Residual (Error)	58.59	18	3.24		
Total	119.2				

Student - Newman-Keuls Comparison of Geometric Means (given back-transformed) for Depths.

	Depth Contour			
	1 m	7 m	3 m	12 m
$e^{\bar{x}}$	2752	645	395	72
Test				*

OCTOBER-NOVEMBER ANOVA

Source of Variation	SS	Deg F	MS	F	Sign. Level
Among Transects	5.00	6	0.833	0.37	Not Sign.
Among Depths	12.03	3	4.01	1.75	Not Sign.
Residual (Error)	61.36	18	2.29		
Total	78.39				

* Means joined by bars are not significantly different at the 5% level.

APPENDIX 7

ANALYSIS OF SPATIAL VARIATION IN LARVAL FISH CATCHES

ANOVA selected: 2-way - Depth Contour x Transect
Surface samples only
No replication - all catches through the season at a location are lumped; seasonal sampling volumes are equal among locations.

RAINBOW SMELT

Variance Table

Source	Sum of Squares	Deg Freedom	Mean Square	F	Significance
Total	819013				
Among Depth Contours	317288	2	158644	6.05	Sign. at 5%
Among Transects	239622	5	47932	1.83	Not sign.
Residual (Error)	262062	10	26206		

Comparison of Depth Contour Means (Student - Newman-Keuls)

Contour	1 m	3 m	7 m
Mean Catch	479	239	169
Test	——	————	

(Means joined by bars are not significantly different at 5% level)

ALEWIFE

Variance Table

Source	Sum of Squares	Deg Freedom	Mean Square	F	Significance
Total	99668				
Among Depth Contours	16070	2	8035	1.31	Not sign.
Among Transects	22211	5	4442	0.72	Not sign.
Residual	61387	10	6138		

APPENDIX 7 (Cont'd)

ANALYSIS OF SPATIAL VARIATION IN LARVAL FISH CATCHES

JOHNNY DARTER

Variance Table

Source	Sum of Squares	Deg of Freedom	Mean Square	F	Significance
Total	1013.6				
Among Depth Contours	110.6	2	55.3	0.87	Not Sign.
Among Transects	269.6	5	53.9	0.85	Not Sign.
Residual	633.3	10	63.3		

BURBOT

Variance Table

Source	Sum of Squares	Deg Freedom	Mean Square	F	Signficance
Total	421.6				
Among Depth Contours	54.11	2	27.0	2.16	
Among Transects	242.3	5	48.4	3.87	Sign at 5%
Residual	125.2	10			

Comparison of Transect Means (Student - Newman-Keuls)

Transect	Bruce 'B' Intake	Bruce 'B' Discharge	S. Boundary Road	Lagoon Bay	Gunn Point	Holmes Bay
Mean Catch	14.0	12.7	9.0	7.7	5.0	4.0
Test						

APPENDIX 8

LENGTHS OF LARVAL FISH TAKEN IN PLANKTON TOW NETS
BRUCE GS "B", 1981

Species	Date	May 14			May 20			May 28			June 17			June 23			July 7			July 23			Aug 6		
		n	x̄	range	n	x̄	range	n	x̄	range	n	x̄	range	n	x̄	range	n	x̄	range	n	x̄	range	n	x̄	range
Rainbow Smelt		246	6.3	4.5-7.5	122	6.1	5.5-7.0	74	6.3	5.5-7.0	12	6.6	6.0-7.5				8	14.0	10.0-20.0						
											13	12.0	8.0-18.0												
Alewife																									
	<7 mm											9.4	6.0-18.0	8	4.6	4.5-5.0	153	5.0	4.5-6.0	17	4.6	4.0-5.5	88	4.6	4.0-5.5
	≥7 mm																29	12.8	6.0-18.0	23	18.5	8.5-25.0	112	17.8	9.0-23.0
Johnny Darter								1		6.0	2	6.3	6.0-6.5				89	6.1	5.0-7.5	8	6.1	5.5-8.0	114	6.7	5.0-8.0
Burbot		62	4.2	3.5-5.0	2	5.25	5.0-5.5	70	4.5	4.0-5.5	2	5.0	5.0	22	5.0	4.5-9.0	2	6.5	5.0-8.0	1		8.0			
Trout-Perch											3	7.0	6.0-8.0				4	6.8	6.5-7.5	1		8.0	41	6.1	5.5-8.5
Slimy Sculpin											1	9.5	9.5	8	9.2	8.5-10.0	9	9.7	9.0-10.0	1		12.0			
Yellow Perch											10	7.0	6.0-8.5	3	6.3	6.0-6.5	4	6.5	6.0-7.0	2	5.8	5.5-6.0			
Deepwater Sculpin		6	11.7	10.0-16.0				2	13.5	13.0-14.0															
White Sucker											1		14.5				1		13.0						
Carp											3	6.7	6.0-6.5												
Logperch																									
Cisco		1		9.0													1		5.0						
Round Whitefish		1		11.0																					

APPENDIX 9

FISH CATCHES IN SHORT DURATION GILL NETS SET IN CONJUNCTION WITH ACOUSTIC FISH CENSUS

Sample		Net No	Transect	Depth	Catch				
					Alewife	Smelt	Burbot	Round Whitefish	Yellow Perch
June 2	Day	1	11	15-20 m					
		2	7	11-18 m				1	
		3	4	26-30 m					
June 2	Night	1	7	30 m			1		
		2	8	12-18 m					
		3	6	12-18 m					
July 7	Day	1	13	15-24 m					
		2	7	30 m			No fish		
		3	1	17-23 m					
July 7	Night	1	11	23-25 m				1	
		2	7	22-30 m			3		
		3	5	15-19 m					1
Sept 3	Day	1	9	15-18 m	1				
		2	11	25-30 m		1			
		3	4	21-23 m					
Nov 4	Day	1	7	5-10 m					
		2	7	27-30 m			No fish		
		3	2	25-29 m					
TOTALS					1	1	4	2	1

APPENDIX 9a

Common and Scientific Names of Fishes

Family	Common Name	Genus and Species
Acipenseridal	Lake sturgeon	*Acipenser fulvescens*
Lepisosteidae	Longnose gar	*Lepisosteus osseus*
Clupeidae	Alewife	*Alosa pseudoharengus*
	Gizzard shad	*Dorosoma cepedianum*
Salmonidae	Pink salmon	*Oncorhychus gorbuscha*
	Coho salmon	*Oncorhynchus kisutch*
	Chinook salmon	*Oncorhynchus tshawytscha*
	Rainbow trout	*Salmo gairdneri*
	Brown trout	*Salmo trutta*
	Splake	*Salvelinus namaycush x S. alpinu*
	Cisco	*Coregonus artedii*
	Round whitefish	*Prosopium cylandraceum*
Osmeridae	Rainbow smelt	*Osmerus mordax*
Esocidae	Northern pike	*Esox lucius*
Cyprinidae	Redbelly dace	*Chrosomus eos*
	Lake chub	*Couesius plumbeus*
	Carp	*Cyprinus carpio*
	Golden shiner	*Notemigonus crysoleucas*
	Emerald shiner	*Notropis atherinoides*
	Common shiner	*Notropis cornutus*
	Rosyface shiner	*Notropis rubellus*
	Spottail shiner	*Notropis hudsonius*
	Mimic shiner	*Notropis volucellus*
	Bluntnose minnow	*Pimephales notatus*
	Longnose dace	*Rhinichthys cataractae*
Catostomidae	Longnose sucker	*Catostomus catostomus*
	White sucker	*Catostomus commersoni*
	Golden redhorse	*Moxostoma erythrurum*
	Shorthead redhorse[1]	*Moxostoma macrolepidotum*
Ictaluridae	Brown bullhead	*Ictalurus nebulosus*
	Channel catfish	*Ictalurus punctatus*
	Stone cat	*Noturus flavus*
Gadidae	Burbot	*Lota Lota*

Appendix 9a (cont'd)

Family	Common Name	Genus and Species
Gasterosteidae	Brook stickleback	*Culaea inconstans*
	Threespine stickleback	*Gasterosteus aculeatus*
Percopsidae	Trout-perch	*Percopsis omiscomaycus*
Percichthydae	White bass	*Morone chrysops*
Centrarchidae	Rock bass	*Ambloplites rupestris*
	Smallmouth bass	*Micropterus dolomieu*
Percidae	Fantail darter	*Etheostoma flabellare*
	Johnny darter	*Etheostoma nigrum*
	Yellow perch	*Perca flavescens*
	Logperch	*Percina caprodes*
	Walleye	*Stizostedion vitreum*
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*
Cottidae	Mottled sculpin	*Cottus bairdi*
	Slimy sculpin	*Cottus cognatus*
	Deepwater sculpin	*Myoxocephalus thompsoni*[2]

[1] = Northern redhorse
[2] = *M. quadricornis*